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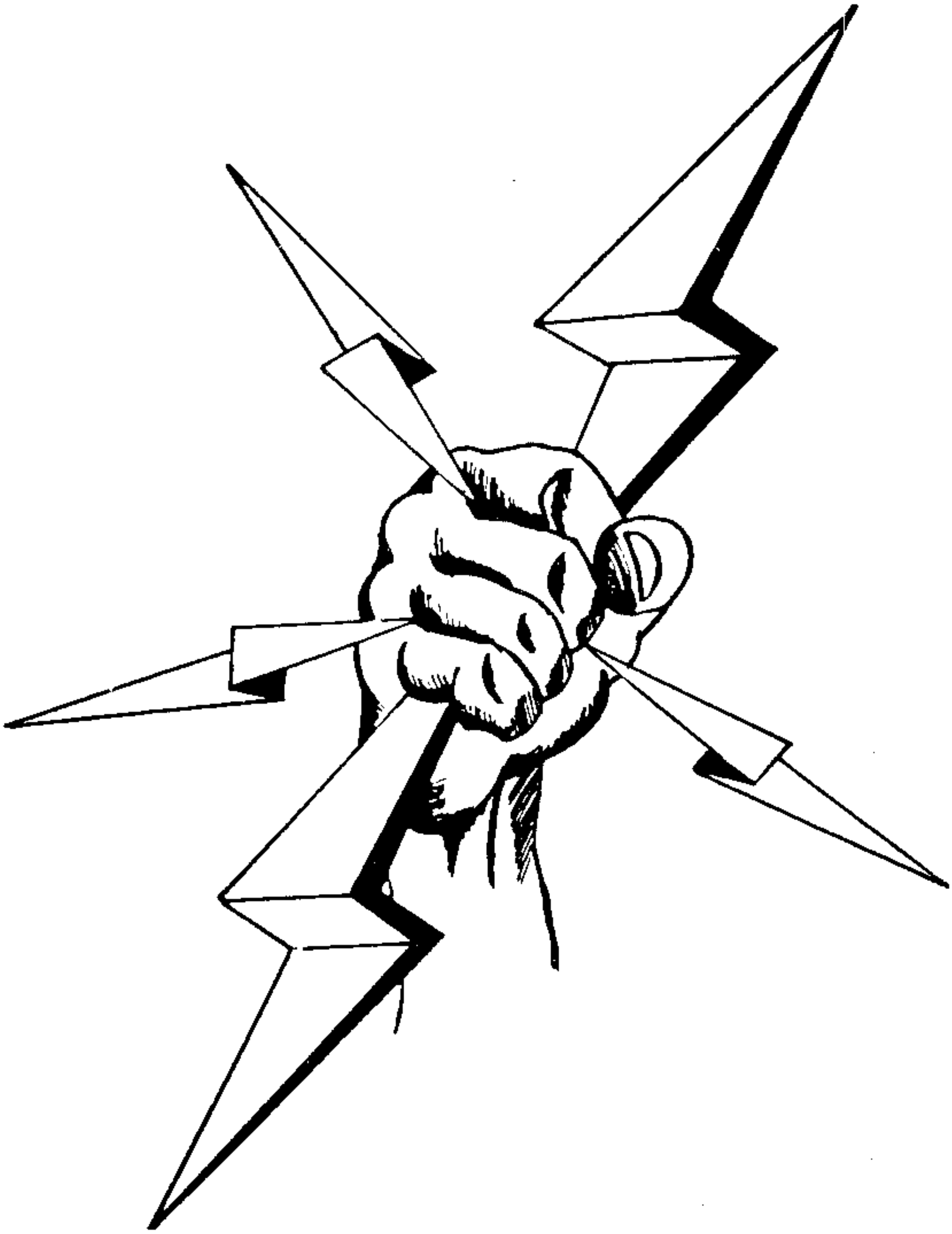
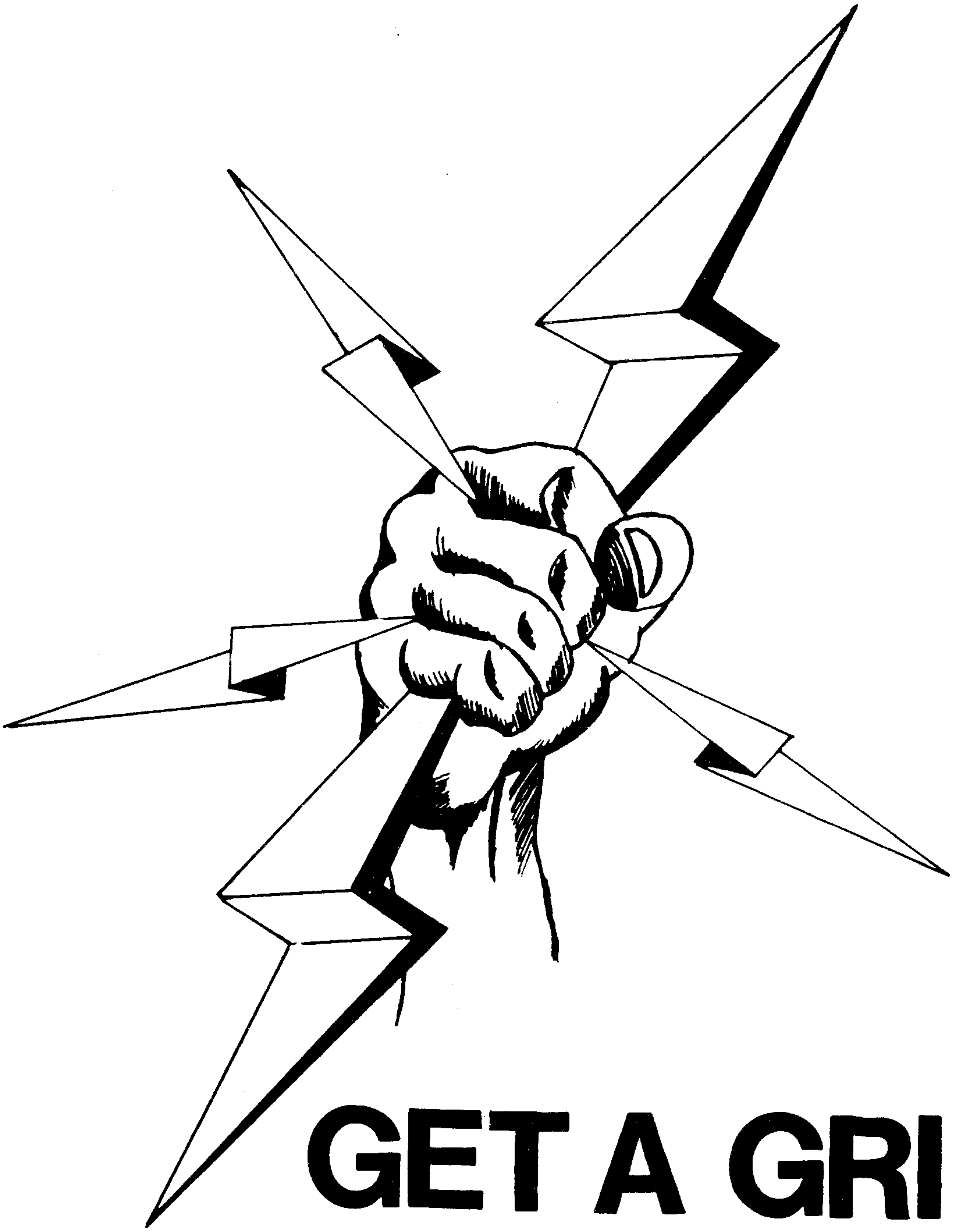


"O" CLASS SUBMARINE ELECTRICAL POWER AND DISTRIBUTION HANDBOOK

FOR

WEEO'S AND PART TWO SAILORS

ELECTRIC POWER –



GET A GRIP ON IT!

SAFETY WARNING

A CURRENT OF 100mA PASSING THROUGH THE HUMAN BODY FOR ONE SECOND CAN KILL. THIS CAN OCCUR AT VOLTAGES AS LOW AS 30V AC OR 50V DC.

1. THE EQUIPMENT DESCRIBED IN THIS BOOK USES ELECTRICAL POWER WHICH CAN BE LETHAL.
2. WHENEVER PRACTICABLE, BEFORE CARRYING OUT MAINTENANCE OR REPAIR, PERSONNEL CONCERNED MUST:
   (1) ISOLATE THE EQUIPMENT FROM THE ELECTRICAL SUPPLY,
   (2) MAKE TESTS TO VERIFY THAT THE ISOLATION IS COMPLETE,
   (3) ENSURE THAT POWER CANNOT BE ACCIDENTALLY RECONNECTED.
3. IF IT IS ESSENTIAL TO WORK ON THE EQUIPMENT WITH POWER CONNECTED, THE WORK MUST BE UNDERTAKEN ONLY BY QUALIFIED PERSONNEL WHO ARE FULLY AWARE OF THE DANGER INVOLVED AND WHO HAVE TAKEN ADEQUATE SAFETY PRECAUTIONS TO AVOID CONTACT WITH DANGEROUS VOLTAGES.

SAFETY WARNINGS

"Electrical circuits and exposed conductors in battery tanks and compartments may be at voltages sufficiently high to endanger life. Work on this equipment should be undertaken only by personnel who are fully aware of the danger involved and who are to take adequate precautions to avoid direct contact with current carrying components.

Work on individual cells may also involve the risk of accidental heavy current discharge at several thousand amperes, causing severe burns and physical injury. No tools or metal articles are to be used or carried into battery tanks and compartmens other than those authorised, which are adequately insulated to avoid accidental short-circuiting. All electrical connections in the battery tank or compartment are to be kept tight.

Hydrogen evolved from batteries is highly inflammable and explosive when mixed with air. All instructions, particularly those relating to battery ventilation and charging limitations, must be strictly observed at all times. Do nothing that might cause a spark in the battery tank or compartment.

Make stipulated reductions in charging rates immediately the battery voltage reaches an average of 2.4 volts per cell. If this is not done gassing may become excessive and the ventilating system may be unable to prevent an explosive mixture from forming in the battery compartment or ventilation trunking.

Extreme care must be taken when handling concentrated sulphuric acid. It is extremely corrosive and produces serious burns if allowed to touch the skin. Wear good rubber gloves and goggles when handling concentrated acid and avoid splashing the acid."

The above is an extract from BR 2075X.

"Modern equipment is susceptible to damage caused by maloperation and incorrect maintenance. All operating instructions are to be understood fully before the equipment is used and all maintainers are to consult the relevant publications before tackling work on unfamiliar equipment. If in any doubt, ask the senior sailor or officer responsible.

We all make mistakes - this is understood. If you make one - report it immediately. If you do not report it, it stops being a mistake and becomes negligence. This is a serious offence.

All sailors, whatever their rank or job, are responsible for reporting any defect which they may discover.

Major Defects. Major defects are those affecting the fighting or seagoing efficiency of the submarine and are to be reported to the OOW or OOD as soon as they arise and to the departmental officer concerned as soon as possible.

Minor Defects. Minor defects are to be reported to the senior sailor in charge of the compartment or equipment in which they arise, who in turn will report the defect to the DMEO or DWEEO as appropriate.

All defects are to be recorded in a Defect Book which is to be kept in a prominent place."

The above extract is from RANSSO Chapter 3, Section 1, SAFETY, 3000-3005.

The main battery of a patrol submarine is its very life blood, and as such, a knowledge of its construction, care and maintenance, for the Electrical Branch, cannot be stressed enough.

The object of this book is to give the reader enough knowledge of submarine batteries to perform his duty to a reasonable standard.

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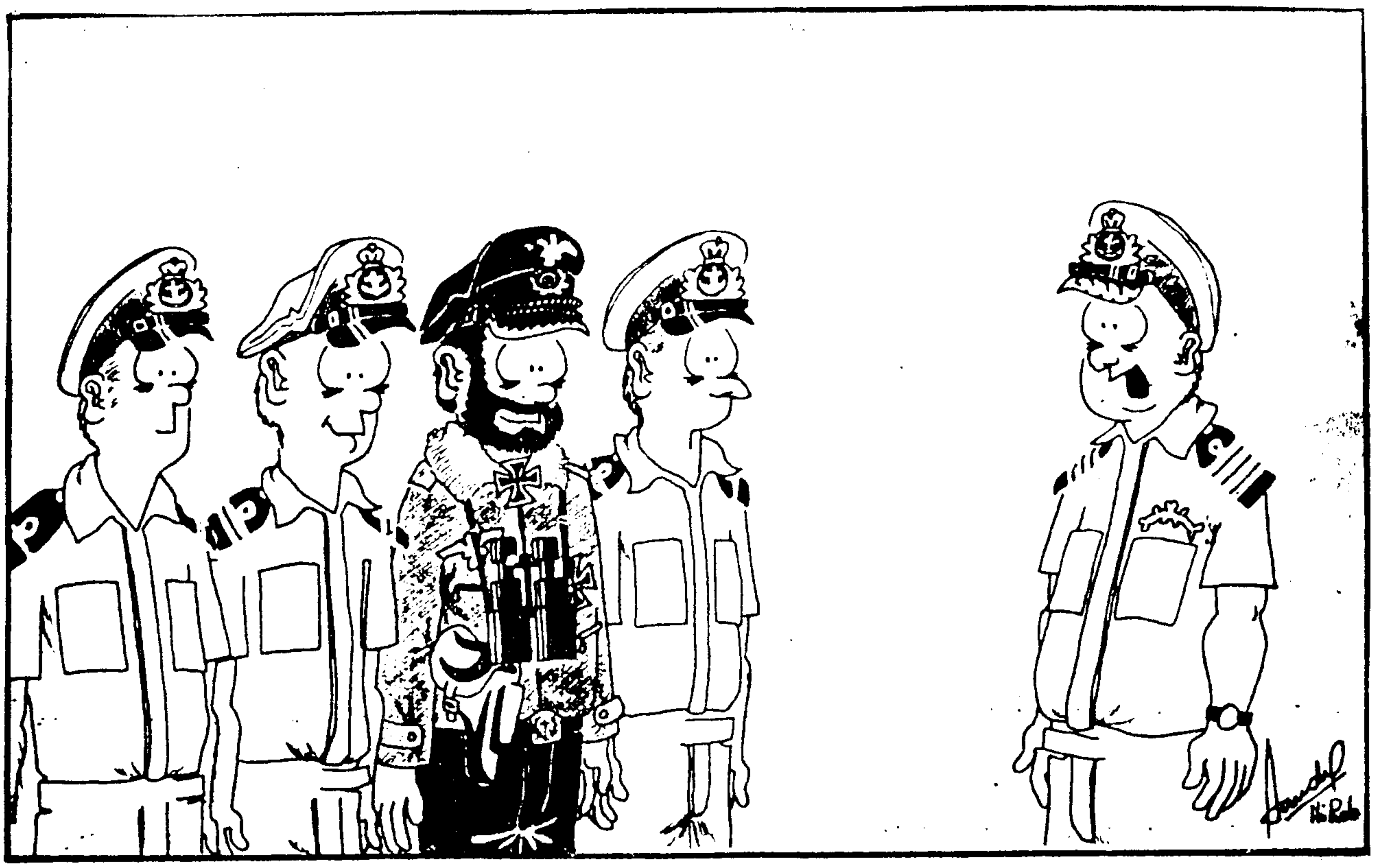


" ANYONE BEEN IN SUBMARINES BEFORE ??"

SECTION 1

SUBMARINE MAIN BATTERIES

1. The Lead Acid Cell

An electrical storage battery is primarily a device for storing electrical energy at one time for use at another. The energy is stored as chemical energy and is delivered again in the form of electricity.

These two processes, known as "CHARGING" and "DISCHARGING" are thus accompanied by a chemical "winding up" and "unwinding" respectively in the battery.

The fundamental unit in any battery is called a "CELL", which basically consists of two dissimilar plates or electrodes containing "ACTIVE MATERIALS", one positive and one negative, which are immersed in a solution called the electrolyte. Several different kinds of chemicals may be used for the constitution of the plates and electrolyte, each combination having its own natural potential or voltage. The most common type of cell uses sulphuric acid and lead compounds, and it is this lead acid cell with which we are concerned.

The natural open circuit voltage of this combination is approximately two volts, and it is important to note that this figure arises from the chemicals used, and not from the size of the cell.

2. The Chemical Reaction

When two dissimilar metals are immersed in an electrolyte a chemical reaction takes place between the metals and the solution. In the case of the lead acid cell, the two metals are made of LEAD PEROXIDE (PbO_2) for the positive plate and PURE LEAD (Pb) for the negative plate, and the solution is DILUTED SULPHURIC ACID, immersing the plates in the liquid causes a chemical action which results in the production of an emf.

3. Cell on Discharge

If we connect an external circuit to the cell a current will flow, and due to the chemical action inside the cell, the positive plate will gradually give up its oxygen content, which combines with the hydrogen of the electrolyte to form water, thus weakening the acid. The sulphur content of the electrolyte combines with the lead of both plates to form LEAD SULPHATE ($PbSO_4$), whilst hydrogen bubbles are formed inside the cell which rise to the top of the liquid and are given off as gasses. This action causes a fall in the specific gravity of the electrolyte and a lowering of cell voltage.

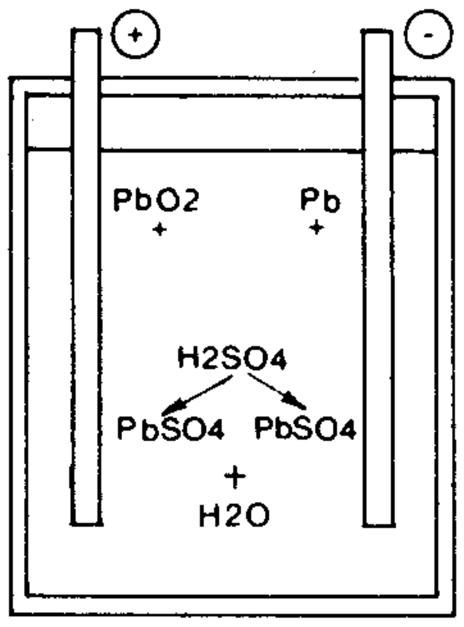


Fig.1 CELL DISCHARGING

Positive Plate

Lead peroxide (PbO_2) combining with Sulphuric Acid (H_2SO_4) to form Lead Sulphate ($PbSO_4$) and water (H_2O), releasing electrical energy.

Negative Plate

Porous metallic lead (Pb) combining with sulphuric acid to form Lead Sulphate and water, releasing electrical energy.

Electrolyte

Acid content falling as sulphuric acid combines with active materials and the amount of water increases.

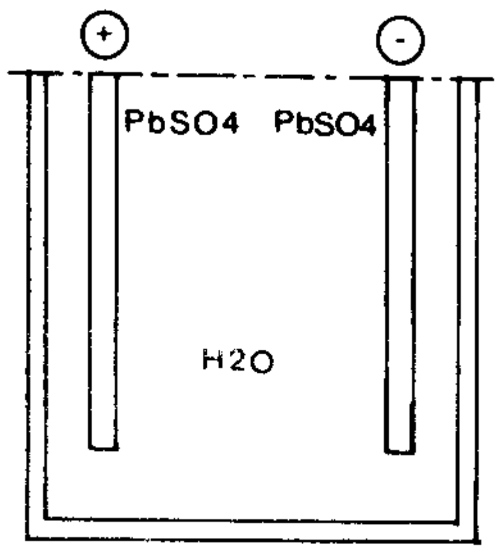


Fig.2 CELL ON CHARGE

Positive Plate and Negative Plate

Active material is now mainly Lead Sulphate ($PbSO_4$).

Electrolyte

Minimum acid content i.e. mainly water (H_2O).

4. Cell on Charge

If we now pass a current in the reverse direction through the cell, the lead and oxygen combine again into lead peroxide in the positive plate; and the sulphate combine again to form sulphuric acid. The cell is now charged.

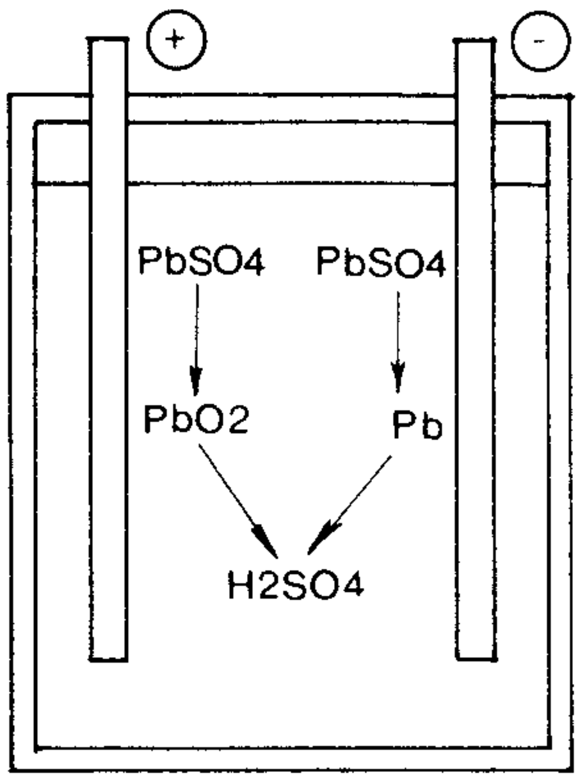


Fig.3 CELL CHARGING

Positive Plate

Lead sulphate being converted to lead peroxide (PbO_2).

Negative Plate

Lead sulphate being converted to pure lead (Pb).

Electrolyte

Acid content increasing by breaking down the sulphate in the plates which re-combines with water to form sulphuric acid (H_2SO_4).

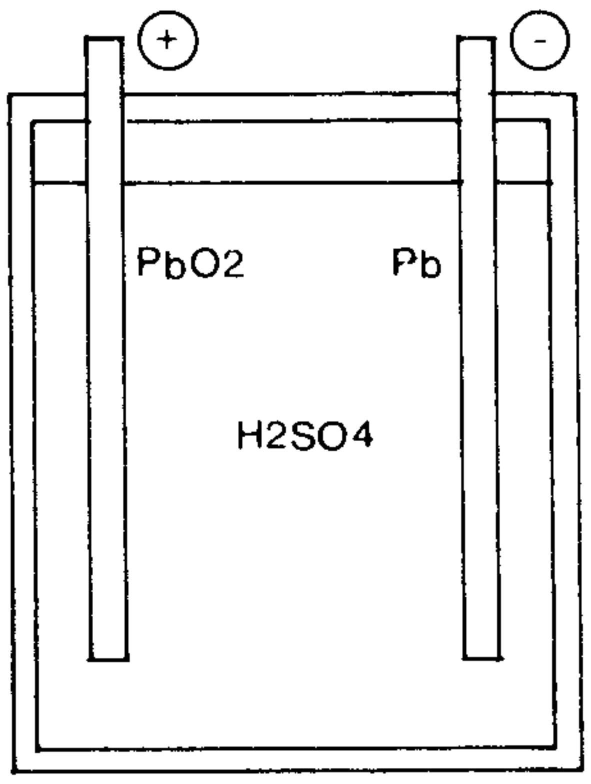


Fig.4 CELL CHARGED

Positive Plate

Active material consists of lead peroxide (PbO_2).

Negative Plate

Active material consists of pure lead (Pb).

Electrolyte

Maximum acid content, the plates have been completely de-sulphated.

5. Requirements for a Submarine Cell

The two main requirements for a submarine cell are:

a. The ability to store a large quantity of energy.

b. The ability to deliver energy rapidly, i.e. in the form of high currents, and conversely to absorb energy rapidly when charging.

a. above depends on the quantity of active material, and if only one positive and one negative were used, they would have to be very large indeed.

b. above depends upon the maximum speed at which the chemical action can take place. This depends upon the amount of active material in the plates which is actually in contact with the electrolyte.

6. Capacity

Capacity of a cell equals discharge current by time (hours) to change the cell from fully charged to fully discharged condition.

The total amount of electrical energy, i.e. the number of ampere hours which may be obtained from a cell depend on:

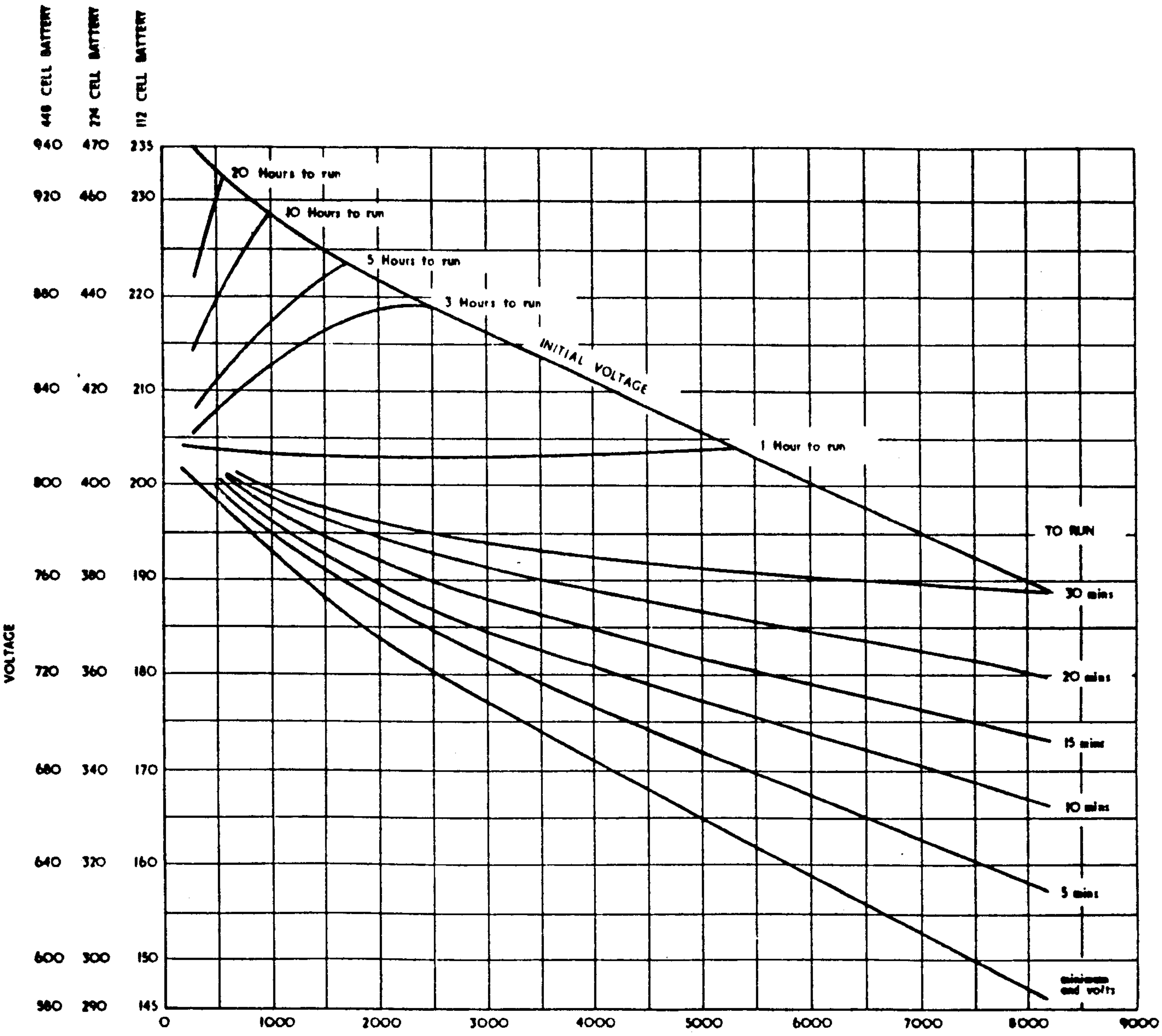
a. Surface area of plates.
b. Number of plates.
c. Material of plates.
d. Nature of electrolyte.
e. The discharge rate.

Large numbers of thin plates are preferable to a few thick ones for high performance, as the acid can penetrate more quickly to the centre layers of each plate; but thicker ones, on the other hand are more robust.

The capacity of all submarine cells is quoted at the five hour rate of discharge, and the pattern or type number of a cell denotes its capacity at that rate, e.g. the present submarine battery is 8400 A/H at the five hour rate, i.e. 8400 divided by 5 = 1680 amps for five hours (to specified final volts).

In practice, capacity remaining can be determined by taking a density reading (dip) or during high rates of discharge, using a "TIME TO RUN GRAPH" used to calculate the approximate time the battery may be discharged at that rate. A copy of this graph is kept in the motor room, and is also contained in BR 2075X.

In practice further capacity is available after a high rate of discharge providing the discharge rate is reduced.



INSTRUCTIONS

(1) DISCHARGE THE BATTERY FOR A PERIOD SUFFICIENTLY LONG TO GIVE STABLE READINGS OF VOLTAGE AND CURRENT.

(2) FIND THE POINT OF INTERSECTION OF THE VOLTMETER AND AMMETER READINGS ON THE CHART.

(3) FROM THE CURVES, READ THE TIME FOR WHICH THE BATTERY CAN BE DISCHARGED AT THE ABOVE CURRENT. N.B. HOURS TO RUN ARE TO MINIMUM END VOLTS.
Example. CURRENT = 2000 AMPERES. VOLTAGE = 196
TIME FOR WHICH BATTERY CAN STILL BE DISCHARGED AT 2000 AMPERES = 30 MINUTES.

7. Lowest Permissible Voltage

The voltage below which a cell must not fall for a given discharge rate.

It is obtainable from the Battery Makers Handbook BR 2075X.

If the cell is discharged below the given voltage at a given discharge rate there will be a rapid fall of current and possibly a complete collapse in current. Any cells which are below the average capacity of the battery are liable to have their polarity reversed.

8. Open Circuit Voltage

Fully discharged - 2V.

Highest voltage depends on age and condition of the cell - 2.65-2.85 V.

BUILD-UP OF A SUBMARINE CELL

9. The Plates

As active materials, when in the porous state, are in need of support and must also be permeated by a conductor system, the plates of a submarine cell are constructed in the form of slender metal grids, filled with active material. The metal grids are made of antimonial lead (i.e. lead with a small amount of antimony in it).

The plates are of the flat pasted type, which, both mechanically and electrically, is heat adapted for operation under the special conditions imposed by the strict limitations in size and weight. The positive plate grids are more robustly constructed than the negative, so as to resist the tendency to corrode and expand under the oxidising conditions to which the positive plates are subjected - i.e. if overcharged, the antimonial lead will also be changed to Pb02.

Furthermore the flat pasted type of plate provides a uniform distribution of current and a minimum internal cell resistance.

There is always an extra negative plate which is fitted to prevent internal emfs in the cell, known as ELECTROLYSIS.

10. The Separators

Cells of the present standard types are fitted with double separation consisting of:

a. A sheet of glass wool felt in close contact with the positive plates.

b. A ribbed separator of micro-porous PVC with its smooth side against the negative plates.

These separators, although they prevent actual contact between the plates, are highly porous and permit the diffusion of acid and the free flow of current between the adjacent plates.

The function of the glass wool separator is as follows:

a. It is a very efficient filter.

b. It prevents erosion of the positive active material.

c. It allows free passage of the electrolyte and gasses.

d. A cell with this type of separator has a very low internal cell resistance, thus ensuring a working voltage at all stages of discharge.

11. The Electrolyte

Diluted sulphuric acid with a density range of 1090 to 1290.

The density of a substance is compared with a similar volume of pure water and is its weight per unit volume. The density of the electrolyte is a measure of the strength of the acid, so, if the upper and lower limits are established, by measuring the density of the electrolyte in a partial discharged cell, some indication of the amount of energy remaining is obtained.

12. Build Up of a Submarine Cell

a. End sheet: made of plastic, is fitted to prevent damage to the rubber cell lining during fitting of the plate groups.

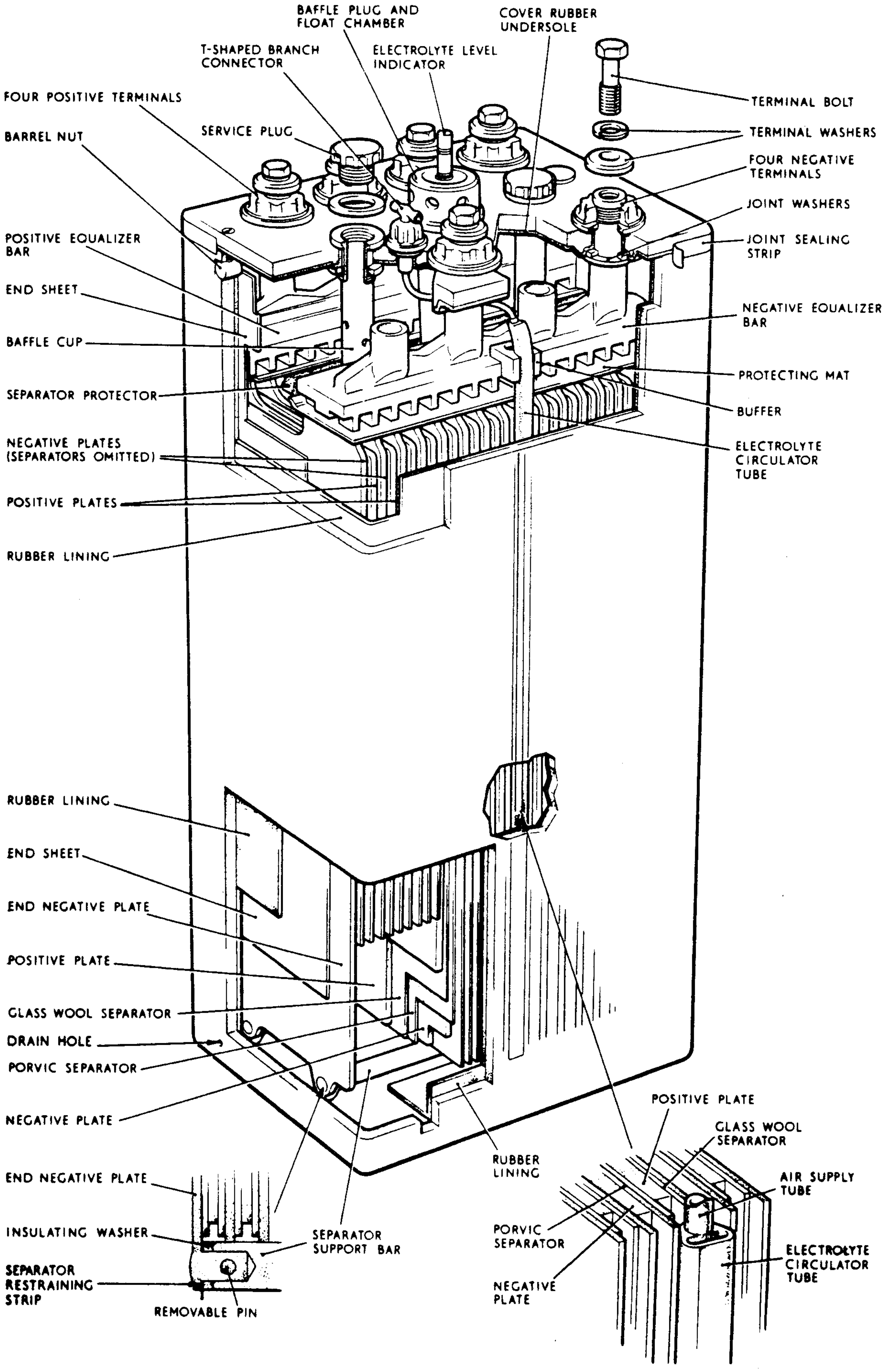
b. Positive Plates. Thicker than the Negative Plates as they are subject to high oxidisation during high rates of discharge.

c. Overall Dimensions

45 inches high (1143 mm)

14 and 5/32 wide (111 mm)

17 and 11/32 long (449 mm)



Typical Submarine Cell

The submarine cell consists of a fibreglass container lined with a rubber bag as a precaution against leakage.

The plates are burnt onto equalising bars and form the positive and negative plate groups. (35+ and 36- in each cell.) The plates are prevented from touching each other by placing separators between them. The plate groups are suspended from the cover which rests on the edges of the container. The bottoms of the plate groups are secured by two plastic rods. These are known as separator support bars as they also prevent the separators slipping from between the plates. Sealing compound is used to make the joint between the cover and the container acid tight. The cover is secured to the container by barrel nuts and screws, the heads of the screws being covered by sealing tape and compound.

13 . Gassing

Gassing is the result of the electrolysis of the water in the cell by excess charging current over and above that which can be absorbed usefully by the plates.

A cell starts to gas at 2.4 volts or 538 volts bus bar voltage per section of 224 cells. High currents passing through the cells above this voltage causes them to give off excessive oxygen and hydrogen gas, and will eventually shorten the life of the cells by having a disruptive effect on the active material in the plates.

Therefore a battery should not be allowed to gas at any charging rate higher than the finishing rate of charge.

A minimum of 10 hours gassing per month is to be achieved as detailed in RAN Technical Addenda (Electrical).

14 . Sulphation

This is the normal chemical action which takes place during discharge. Excessive sulphation however is harmful to the cell and can be caused by discharging the cells and then leaving them in an idle condition for long periods. A possible cure for this condition is to give the cell a long slow charge at a rate not below the final charging rate, ensuring that gassing takes place to remove sulphation.

To ensure that submarine cells are not allowed to sulphate, they are given routine charges and discharges.

15 . Acid Level Float Indicator

A device fitted to the cells to indicate when the correct amount of distilled water has been added.

It consists of a hollow plastic tube with a float at one end; on the body of the tube are two sets of rings. When the green set of rings just emerges from the guide on the top of the vent plug, the correct amount of distilled water has been added.

16. Electrolyte Agitation System

With the advent of extra high capacity cells, reduced separator thicknesses have led to increased problems of STRATIFICATION of the cell electrolyte. This effect tends to cause a loss of capacity.

To overcome this problem, the battery electrolyte agitation system is fitted. This assists by mixing the electrolyte after topping up.

A multistage blower located in the AMS, supplies air to a header pipe in each battery compartment at 1.5 - 2lb. Nozzles are fitted to each header pipe to enable connections to be made, by soft tubing, to individual longitudinal rows of cells, via a plastic "T" piece.

Each agitator is a form of lift pump consisting of a polystyrene agitator tube situated adjacent to a positive plate edge near the middle of the plate group. This tube is located by an ebonite buffer secured to the negative equalising bar. The agitator tube extends from the bottom of the plate group to within about3/8 inch above the normal level of the electrolyte in the cell. A second tube for air supply is located inside the agitator tube and extends about half way down the length of it. The top end of the air supply tube fits inside an ebonite "T" piece which is secured to the top of the cell. The "T" piece can be adjusted to point in any direction to provide for attachment of the soft plastic tubing.

17. Operation of Agitation System

Air from the header pipe passes through the tubing to the plastic "T" piece, and via a small bleed hole inside the "T" piece, passes into the supply pipe. The air then rises to the top of the circulator (agitator) tube and in so doing draws the electrolyte with it from the bottom of the cell. Thus the "heavy" electrolyte is passed to the top of the cell and density layers are avoided. The spent air leaves the cell through the vent plug. It should be remembered when first starting the agitation system, that it takes about four hours to circulate the 17½ gallons of electrolyte of each cell.

18. Times to Run the Agitation System

a. Before charging, during and after the charge.

b. After topping up with distilled water.

c. As required to "mix" the electrolyte.

d. When breaking a vacuum.

e. Twice daily in harbour(AM & PM)

NOTE: Do not run the agitation system during high current discharges, as all the heat will be at the top of the cell and the best place for it to be removed by the battery cooling system.

19. The Build-Up of the Submarine Main Battery

The two main batteries of an OBERON class submarine each comprise 224 type 8400 connected in series.

The two batteries are provided with terminal cooling and air agitation systems and can be connected in series or parallel to give a nominal voltage of 880 and 440 V at the main power bus bars.

The output of the batteries is connected to the main power bus bars via electrically operated breakers situated in the battery switchboards. Each battery has its own battery switchboard.

The batteries (224 cells) can be further sub-divided into sections of 112 cells each by means of a MID POINT LINK SWITCH, situated at the battery switchboard. Each battery has its own mid point link switch.

20. Battery Compartments

The batteries are housed in compartments which can be entered by two access hatches, one in each battery section.

No. 1 battery is under the accommodation space.

No. 2 battery is under the Wardroom and Control Room.

The compartments are coated with a rubberised substance which besides protecting the metal from acid, forms a means of insulation for the compartment. Waxed teak boards are arranged on the deck of the compartment, the cells resting on these when they are in position.

Each cell carries a number: $\frac{2}{104}$

The top number indicates the battery to which that cell belongs; the bottom number indicates the position of the cell in that battery according to the battery plan.

The cells are lowered one by one into the compartment, and rest on the waxed teak boards. Each cell is stowed according to the battery plan, the outboard row being stepped to facilitate maintenance. When all the cells of a section are stowed, the wedging up takes place (certian spaces called wedging spaces are left provided, and soft wooden wedges are then driven down the sides of the cells) and the cells are then firmly held in place. The terminal cooling plates are now fitted, then all the cells are connected up in series, using the inter-cell connectors. The air agitation system is fitted and finally wooden catwalks are provided to enable servicing of the battery to be carried out.

Compartments must conform to the following:

a. Be completely protected against sulphuric acid (lined with Rosbonite and tested during refit with a spark tester to 5 kV.

b. Cell supports must be strong but resilient (waxed teak boards on rubber mounts).

c. Adequate ventilation.

d. Must have hatches and catwalks to facilitate maintenance.

Cells are interconnected in such a way that the magnetic fields set up by current flowing through the copper conductors will effectively cancel each other out and the resultant magnetic field will be zero.

21. Battery Sumps

Purpose - to collect any liquid which may otherwise lay in the bottom of the battery compartment.

A sighting tube is fitted for each battery compartment, No. 1 in the Coxswain's store and No. 2 in the AMS.

NOTE: The key for the battery sump main line suction valves is kept on the important key board in the wardroom.

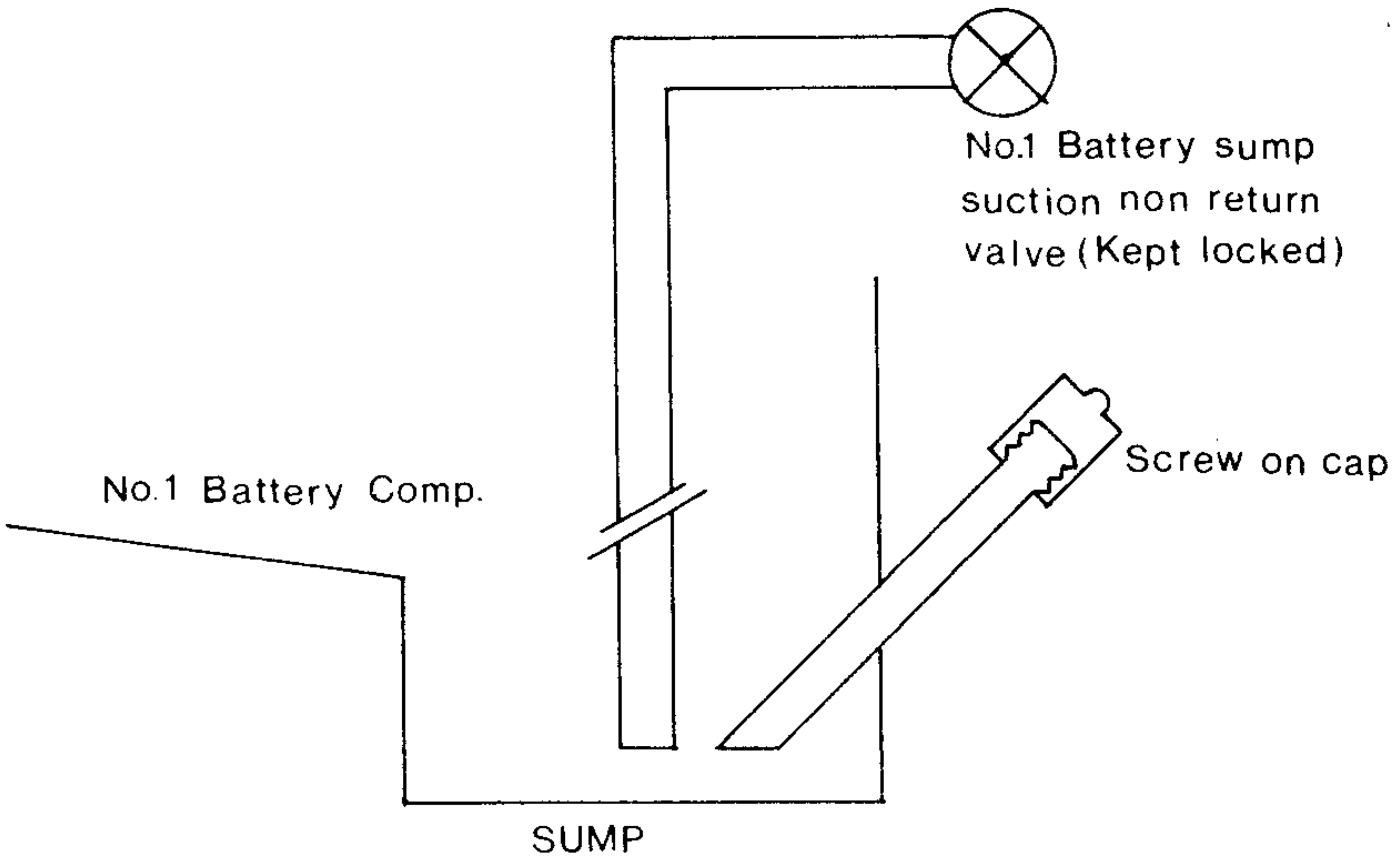


Fig. 7

NOTE: Care must be taken to ensure that the screw on the cap is replaced each time a sump is sighted.

The battery sumps must be sighted at the routine intervals laid down in the Submarine Standing Orders. If any liquid is found in a sump, it must be tested to find out its composition before its removal, litmus paper or a density reading will indicate an acid content. If acid is present, soda should be added to neutralise it before pumping the sump dry.

22. Battery Sump Sighting Routine

Battery sumps should be sighted at the following times:

DAILY IN HARBOUR - a.m. and p.m.

AT SEA - once every two hours at sea.

CHARGING - before putting on a charge

ALSO - after any unusual event i.e. collision, depth charging, grounding e.g. Heel > 40°/Pitch > 35°/ Combined > 50°

AND AS PER THE ELECTRICAL STANDING ORDERS

23. Battery Compartment Suction Valves

A connection to the main line is fitted to each battery sump for pumping out purposes. This valve is known as the battery compartment suction and is ALWAYS KEPT SHUT AND LOCKED; the key will be found on the important keyboard.

24. Routine for Pumping out a Battery Sump

a. Determine whether or not the content of the sump is acid. If so, it must be neutralised (paragrpah 18 refers).

b. Obtain permission to pump the sump and draw the key (important keyboard).

c. Inform ballast pump that battery sump is being pumped.

d. Unlock battery sump main line suction.

e. Order ballast pump to pump from for'd.

f. When ballast pump has a good suction 20 Hg on the main line, open the battery sump main line suction.

g. When the sump is dry, shut the battery sump main line suction and lock it. The ballast pump may only be stopped when the battery sump main line suction is shut.

h. Return the key and report to OOW/OOD.

25. Pilot Cells

These are cells chosen for ase of access and are used to give a general indication as to the state of the battery as a whole. Two pilot cells from each battery are chosen; i.e. One from each half section. Usually only one pilot cell from each battery is dipped and they vary from boat to boat, the pilot cell from No. 2 battery aft section is not normally dipped for routine dips but either fwd/or aft can be used on No. 1 battery.

26. Battery Reading (Dips)

These consist of the density of the pilot cells in use, corrected for temperature.

27. Routine Times to Take Battery Dips.

a. Daily in harbour - a.m. - p.m.
b. At sea - once every two hours at sea.
c. As part of pre charge checks.
d. Hourly during a charge.
e. Half hourly during the final stages of an equaliser charge,ie. from 2½ hours after timing point.
f. Every 15 minutes during the final stages of a conditioning discharge.
g. Prior to Harbour Stations.
h. As required, e.g. when reverting from V.P. emergency or CPA/CPB.

28. The Hydrometer

The hydrometer is an instrument used to determine the specific gravity of a liquid. It is a hollow glass tube to which is added a scale, and at one end of the tube is a pre-determined weight. When the hydrometer is floated in the liquid, the scale is read where it cuts the liquid.

29. The Effect of Temperature on Density

The electrolyte expands with heat during charging, and contracts when cooling. It follows that the weight per unit will vary correspondingly (see Electrolyte, page 6), therefore a temperature correction must be applied to the hydrometer reading.

The standard correction to work from is 60°F.

The following corrections are to be applied every time a density reading is taken:

a. FOR EVERY 10° F ABOVE 60° F, ADD 4 POINTS TO SG.

b. FOR EVERY 10° F BELOW 60° F, SUBTRACT 4 POINTS FROM SG.

For example:

Hydrometer reading is 1240
Temperature is 95° F

Therefore 1240 + 14 = 1254. This then, is the true density reading.

30. The Effect of Temperature on Voltage

The temperature has a considerable effect on the voltage during a charge, particularly during the latter stages of an equalising charge. This is due to the fact that as the temperature increases, the internal resistance of the cells increases. This causes a drop of terminal volts.

During the latter stages of an equalising charge it is necessary to take into account the effect the temperature is having on the battery voltmeter readings, and this is done by applying the following corrections. The standard correction to work from in this case being 80° F.

FOR EVERY 224 CELLS, ADD 2 V FOR EVERY 4° F ABOVE 80° F

FOR EVERY 112 CELLS, ADD 1 V FOR EVERY 4° F ABOVE 80° F

SUBTRACT THE CORRECTION IF TEMPERATURE IS BELOW 80° F

A voltage correction table will be found in the battery log.

The above correction is only applied during the latter stages of an equalising charge.

The temperature of the cells in the main battery should never be allowed to exceed 125° F. Should this temperature be reached during a charge, the charge is to be broken.

A charge so suspended may however, be resumed and continued to completion as soon as temperature conditions allow.

If the temperature reaches 115° F during the final stages of a charge the EM on the charge is to inform the duty officer at once. If the duty officer is not available, the EM is to break the charge.

If at any other stage of the charge the temperature reaches 115° F, the EM is to reduce the charging rate, informing the duty officer of the action taken.

32. The Battery Log

The object of this record is to give a complete history of the main battery so that its performance can be assessed at any time, particularly in the event of defects arising before the battery has given its designed useful life.

An entry must be made in the battery log when anything affecting the battery is carried out.

33.

34. Battery State Boards

There are two Battery State Boards. One outside the Wardroom and one in the Control Room. All battery readings are to be entered on these as well as in the Motor Room Log. The purpose of the state boards is to keep the Command informed as to the state of the batteries at all times.

35. Precautions when Working on Main Batteries

The presence of high voltages in OBERON class submarines must be born in mind at all times, and no maintenance is to be carried out or work undertaken on the main batteries unless the following precautions are taken:

a. Transfer load to other battery section.

b. Trip main and auxiliary power breakers of section to be worked on.

c. Open mid-point link switch.

d. No metallic objects of any kind are allowed in battery compartments.

SUBMARINE MOTOR ROOM LOG *(Section 1)*

Date	Time	Busbar Voltage	No 1 Battery		No 2 Battery		Charge/Discharge Amps		Battery				SALINOMETERS		Earth Volts	
													System Pos'n 1	Purifier Local		
			Density	Temp	Density	Temp	No 1 Batt	No 2 Batt	Vent	Agit	Cool	Sumps	0 – 60	0 – 5	+ve	−ve

SUBMARINE MOTOR ROOM LOG RECORD SHEET *(Section 2)*

Main Gen Air Temp		Generator Load KW		M M Arm Current				M M Group	100KW		400Hz		60Hz		4KW		V P Cont'r	Cathalcu Ammeter Readings				Remarks	Signature
				100s AMPS					M/Gs		M/Gs		M/Gs		M/Gs			Engine Services		After Services			
									MACHINE RUNNING AMPERAGE									Marine Growth	Trap Anode	Marine Growth	Trap Anode		
Port	Stbd	Port	Stbd	PF	PA	SF	SA		1	2	3	4	5	6	7	8							

e. No smoking in the compartment immediately above the battery compartment.
f. Battery ventilation opened up and fans running.
g. Wear rubber soled shoes and wear overalls.
h. Provide rubber mats.
i. Soda solution made up and available outside the compartment.
j. Hatch surround cleared of loose gear.
k. Make a warning pipe (NO SMOKING) and routine pipes every 15-20 minutes.

36. Sick Cells

These will be found during a routine known as ALL ROUND READINGS. Any cell whose density at the end of an equalising charge is 20 to 25 points below the average for the remaining cells of that section should be regarded with suspicion.

This may be due to a fault in the agitation system. If this is not so the facts should be reported to the electrical officer.

There is sometimes a tendency for pilot cells to develop lower densities than the remaining cells, due to spillage of electrolyte when taking readings. This should be born in mind before deciding that the cell is sick.

Sick cells can be isolated from the remainder of the battery by means of a cutting out device. Four of these are supplied to each submarine and include full instructions for fitting.

A cell isolated in one battery must have a corresponding cell isolated in the other battery.

Gassing voltage and timing point voltage must be adjusted accordingly - i.e. 2.4 volt reduction for each cell isolated in a battery.

37. Cell Lifting Gear

Special equipment is provided to transport the cells. It consists of a lifting top which is secured over the top of the cell; two leg irons, which are attached to the lifting top and whose feet fit beneath the container to support its weight, and two breaking out irons, which are thin round steel rods and are used to break the first cell out of the battery section.

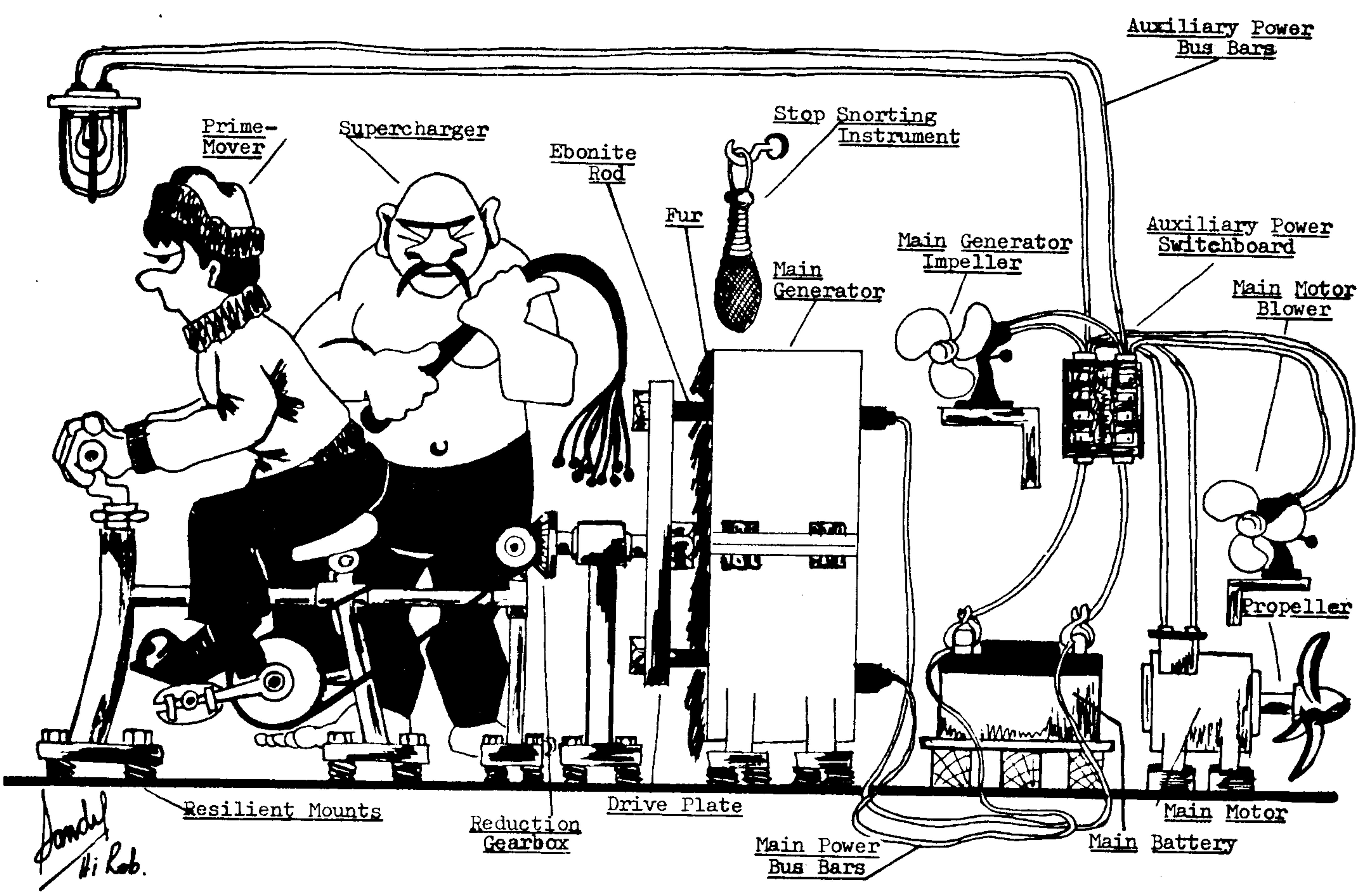
It is important for the safety of all concerned to ensure that the leg irons are shipped whilst cells are being transported in or out of the boat.

38. Charging

Re-charging the submarine's batteries is achieved by running up the diesel engines to which the generators are permanently coupled. If the output of the generators is fed to the batteries via electrically or manually operated breakers re-charging can take place.

There are five ways in which a submarines main batteries may be charged:-

i) by the diesel generators
ii) 440V via the port generator breaker (from shore)
iii) 440V via the battery switchboards (from shore)
iv) 220V via the battery switchboards (from shore)
v) from another submarine (preferably an "O" boat)



39. Methods of Charging

a. Standing Charge. Main motors not in use, all current from the generators is available to re-charge batteries and supply the auxiliary load.

b. Running Charge. Main motors in use, any excess current from the generators passes to the batteries.

c. Floating the Load. Output from the generators is equal to the total of the main motors and auxiliary machinery.

d. Shore Charge. Generators not used, shore charging cables connected to port generator breaker via links or direct to battery switchboards.

40. The Charging Rate

The rates of charge used in OBERON class submarines are as follows:

Higher Initial	1650 amps below 1190 sg
Initial	1250 amps above 1190 sg
Intermediate	825 amps
Final	280 amps

Charging at less than the final rate i.e. 280 amps, is not to be attempted when the bus bar voltage is above 504 volts (trickle charging) as this will cause damage to the cell plates.

41. Types of Charge

a. Constant Current

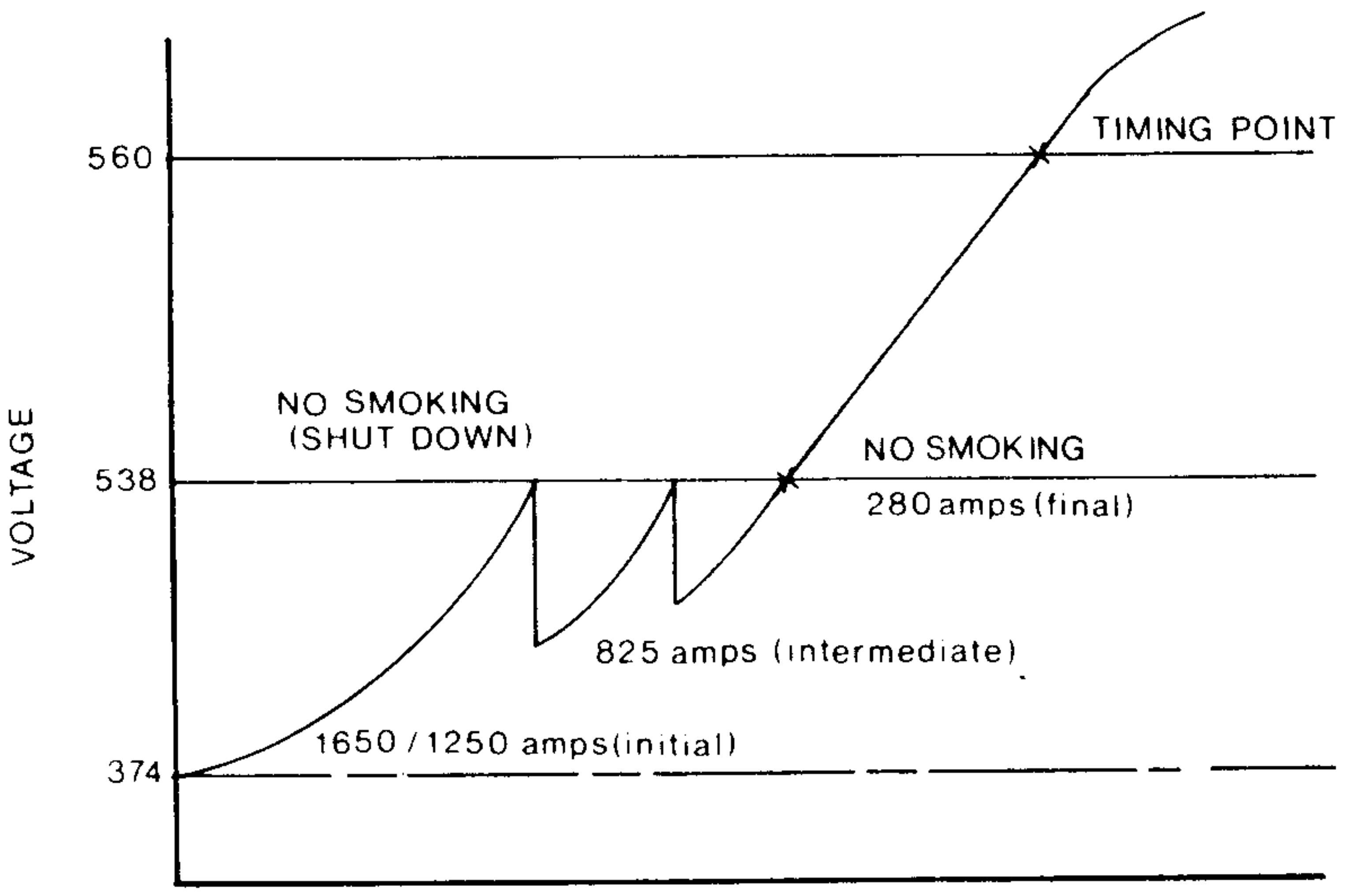


Fig. 8

This type of charge is started at the higher initial rate, if the density is below 1190, or at the initial rate if above. When the voltage reaches 538 volts with this rate flowing, the current is reduced to 825 amps. When the voltage again reaches 538 volts the current is again reduced, this time to the final rate of 280 amps. When the voltage reaches 538 volts at this final rate, the NO SMOKING lights are switched on.

When the voltage reaches 560 volts at the final rate, this is known as the TIMING POINT of the charge and indicates when the charge will be completed.

This type of charge takes time, but requires less vigilant watchkeeping and battery temperatures will be considerably lower than for a constant voltage charge. This type of charge is to be used for normal and equalising charges, when time and operational requirements permit.

b. Constant Voltage

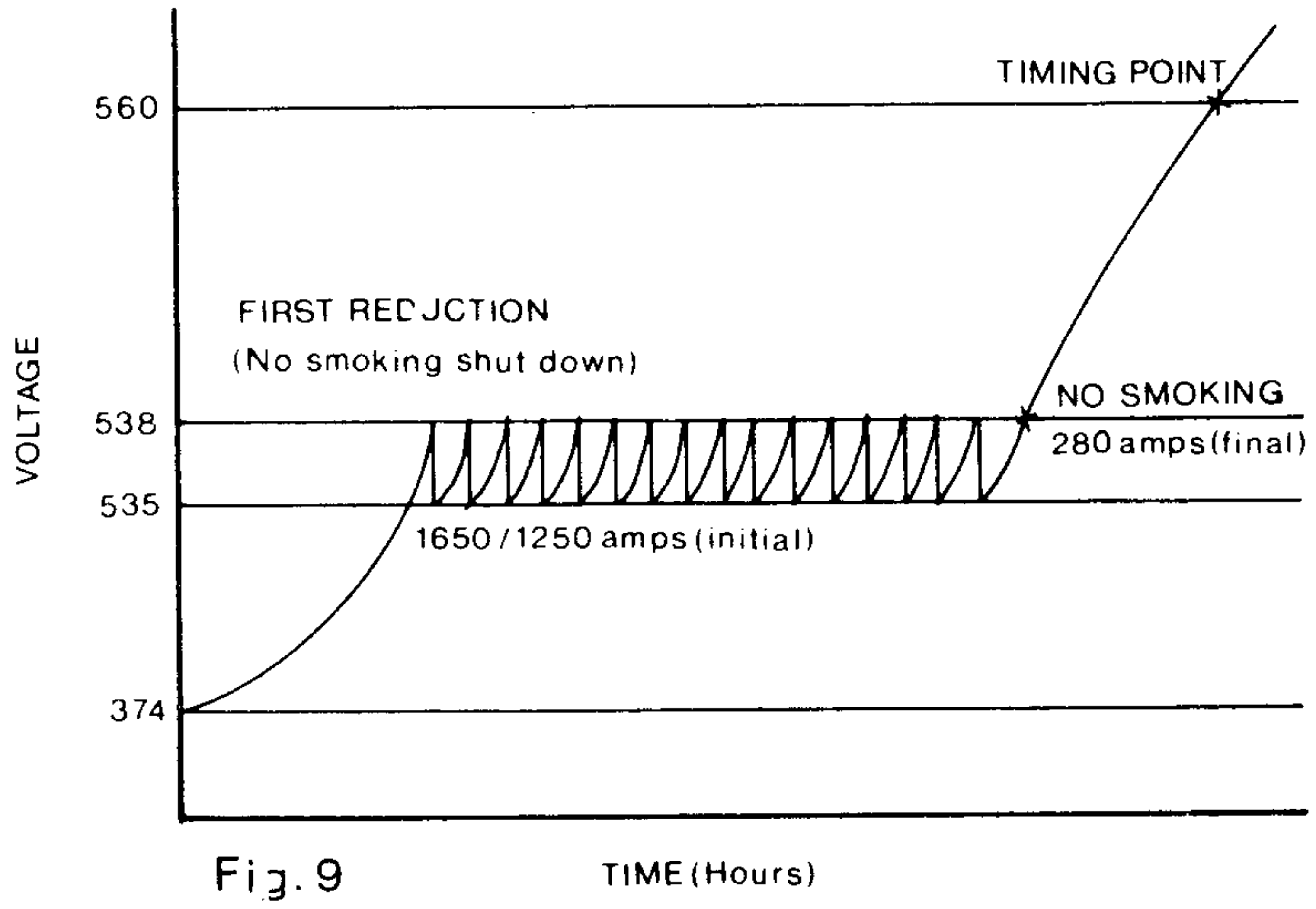


Fig. 9

This type of charge is started as before, and when the voltage reaches 538 volts, it is reduced by a 3 volts to 535 volts; when the voltage again reaches 538 volts it is again reduced and these reductions continue till the charging current is at the final rate (280 amps). When this point is reached i.e. 538 volts at 280 amps, "NO SMOKING" is piped as before and the charge is continued at 280 amps till timing point (560 V) as before.

This is the quickest type of charging but requires vigilant watch-keeping and causes a quicker rise in battery temperatures.

To be used for operational charges and whilst snorting.

42. Voltage Range of Main Batteries

The voltage range of the main batteries of an OBERON class submarine is 374 volts to 630 volts approximately.

43. No SMOKING Regulations

RANSSO's must be consulted, but the following general conditions apply.

a. When battery voltage reaches 538 V at the initial rate of charge whilst running shut down (snorting or surface snorting), i.e. First Reduction.

b. When battery voltage reaches 538V at the final rate of charge whilst opened up, i.e. Final Reduction.

c. For one hour after a gassing charge is complete while the battery ventilates.

d. When battery compartment hatches are open.

e. When battery temperature reaches 115° F.

f. At a high rate of discharge (RANSSO 5023).

44. BATTERY EARTHS

Leakage paths may be formed in a battery, either between the cells and the hull(earth) or between the cells with no connection to earth, resulting from one or other of the following causes:-

i) Spillage of electrolyte or water onto the cell tops
ii) The rubber lining of the cell developing a leak.
iii) Impurities in the battery cooling system.

45. TESTING FOR BATTERY EARTHS

The insulation of the battery is best measured in terms of leakage current flow to earth, by using an AVO, model 48A, in accordance with the procedure laid down in BR2075X chapter 8 paragraphs 4 to 11. Before measuring the leakage current however it is necessary to ensure that the battery is free from an earth fault sufficiently serious as to endanger the maintainer while doing the milli-amp leakage test. This test is to be carried out as a weekly routine and the readings recorded in the battery log.

46. LOCATIONS OF EARTHS

If there is a single earth on the main battery, its approximate position can be found by following the routine laid down in BR2075X chapter 9 paragraph 38. An example is shown below:-

If Vp is 225V and Vn is 245V then the position of a single earth on the battery will be:

$$\frac{Vp}{Vp + Vn} \times 224 = \frac{225}{470} \times 224 = 107.2$$

i.e., at the one hundred and seventh cell from the positive terminal of the battery section.

47. V.P. EARTH VOLTMETERS AND V.P. EARTH FAULT FINDING

1. When the system is healthy both meters will read ½ system volts and will add up to the busbar voltage.

2. When an earth fault exists one voltmeter will read high and the other low, and will still add up to the busbar voltage. The correct procedure would then to isolate each battery in turn and establish whether the fault is on either battery or on the system. A Main Power Earth Finding guide is layed out in BR 1964(19A)

TECHNICAL ADDENDUM NO. 44

MAIN BATTERY CHARGING ROUTINES

1. The tables below set out Submarine Main Battery Charging Routines periodicities. The instructions contained in these tables are to be complied with by all RAN OBERON class submarines. They also supersede the instructions contained in BR 2075X, Part 1, Chapter 5, paragraph 33.

2. Dependant on the condition of the battery agitation system, (by planned maintenance routine LB 1, 3M.2, Battery Agitation System check), charging routine periodicities are to be in accordance with either Table 1 or 2 below, according to the following criteria:

a. If agitation is functioning correctly on all cells, Table 1 is to be used.

b. If agitation is not functioning correctly on all cells, or if the planned maintenance routine has not been carried out in the previous three months, Table 2 is to be used.

Table 1 - Charging Routines Periodicities with Correct Battery Agitation

	Battery in Regular Service	Battery Lightly Worked	Battery Idle
Operational Charge Continued at the finishing rate, until the overall battery voltage has reached 560 V (2.5 V/cell)	As required to give 10 hours gassing/month within a min of 2.5 hours/week	None Required	None Required
Normal Charge Continued for FOUR and A HALF hours (8400) at the finishing rate after the overall battery voltage has reached 560 V (2.5 V/cell).	Fortnightly i.e. five during 13 week cycle	Monthly	None Required
Equalising Charge Continued for at least SEVEN hours (8400) at the finishing rate after the overall battery voltage has reached 560 V (2.5 V/cell). See Note 4 for termination conditions.	Two monthly	Monthly Midway between normal charges	Monthly
Conditioning Discharge At the FIVE hour rate or lower until the specified final voltage for the selected discharge rate is reached.	Four monthly	Quarterly	Quarterly

Table 2 - Charging Routines Periodicities With Nil or Incorrect Agitation

	Battery in Regular Service	Battery Lightly Worked	Battery Idle
Operational Charge Continued for ONE hour at the finishing rate after the overall battery voltage has reached 560 V (2.5 V/cell).	As required to give 10 hours gassing/ month with a min of 2.5 hours/week.	None Required	Non Required
Normal Charge Continued for and FIVE and ONE HALF (8400) at the finishing rate after the overall battery voltage has reached 560 V (2.5 V/cell).	Fortnightly i.e. five during 13 week cycle.	Monthly	Non Required
Equalizing Charge Continued for at least EIGHT hours (8400) at the finishing rate after the overall battery voltage has reached 560 V (2.5 V/cell). See Note 4 for termination conditions.	Two Monthly	Monthly. Midway between normal charges.	Monthly
Conditioning Charge At the FIVE hour rate or lower until the specified final voltage for the selected discharge rate is reached	Four Monthly	Quarterly	Quarterly

NOTES:

1. The durations of charges after the overall battery voltage has reached 560 V (2.5 V/cell) as specified in the tables above are to be strictly adhered to. The battery agitation system should be operated at all times as required by the regulations laid down in Chapter 5 of BR 2075X so that such benefit as may be available from its operation is utilized.
2. The Commanding Officers of HMA Submarines are to report all incidents of "Sick Cells" to the Commander Australian Submarine Squadron who will forward a full report to Navy Office (DSMR).
3. ALL ROUND READINGS are to be taken in accordance with BR 2075X, Chapter 8, paragraph 28(c).
4. Equalizing charges must be continued until:
   a. Half-hourly readings of the battery voltage, corrected to 25° C or to 80° F show no rise over four hours.
   b. Half hourly pilot cell readings of specific gravity, corrected to 60° F (15.6° C) have not risen by more than 0.002 (two points) during the last hour. Charging should be continued even if the specific gravities rise above the specified maximum. High specific gravities should be reduced as soon as possible to within the limits defined:
   TYPE 8400 - 1.287 to 1.292.

ANNEX 1A

TABULATED AND GRAPHICAL TECHNICAL DATA

TABLE ANN 1A.1 CELLS TYPE 8400 - DATA

SPECIFIED OUTPUT

Duration of Discharge (hours)	Rate of Discharge (amps)	Ampere - hour Discharge	Mean Volts	Minimum final volts	
				Per Cell	224 Cells
½	8200	4100	1.54	1.31	293
1	5300	5300	1.68	1.46	327
3	2467	7400	1.85	1.61	361
5	1680	8400	1.89	1.67	374
10	940	9400	1.94	1.73	388
20	510	10200	1.96	1.77	396
40	271	10840	1.97	1.78	401
60	186	11160	1.98	1.79	402
100	113	11300	1.985	1.80	403

CAPACITIES AVAILABLE

Discharge Current (amps)	Time for Complete Discharge		Ampere - hours Discharge	Minimum final volts	
	hours	minutes		Per Cell	224 Cells
200	55	00	11000	1.79	402
300	36	00	10800	1.78	400
400	26	00	10400	1.775	398
750	13	00	9750	1.745	391
1000	9	18	9300	1.72	385
2000	3	57	7900	1.65	368
3000	2	18	6900	1.58	354
4000	1	30	6000	1.53	341
6000	0	49	4900	1.43	320
7000	0	39	4550	1.38	310
8200	0	30	4100	1.31	293

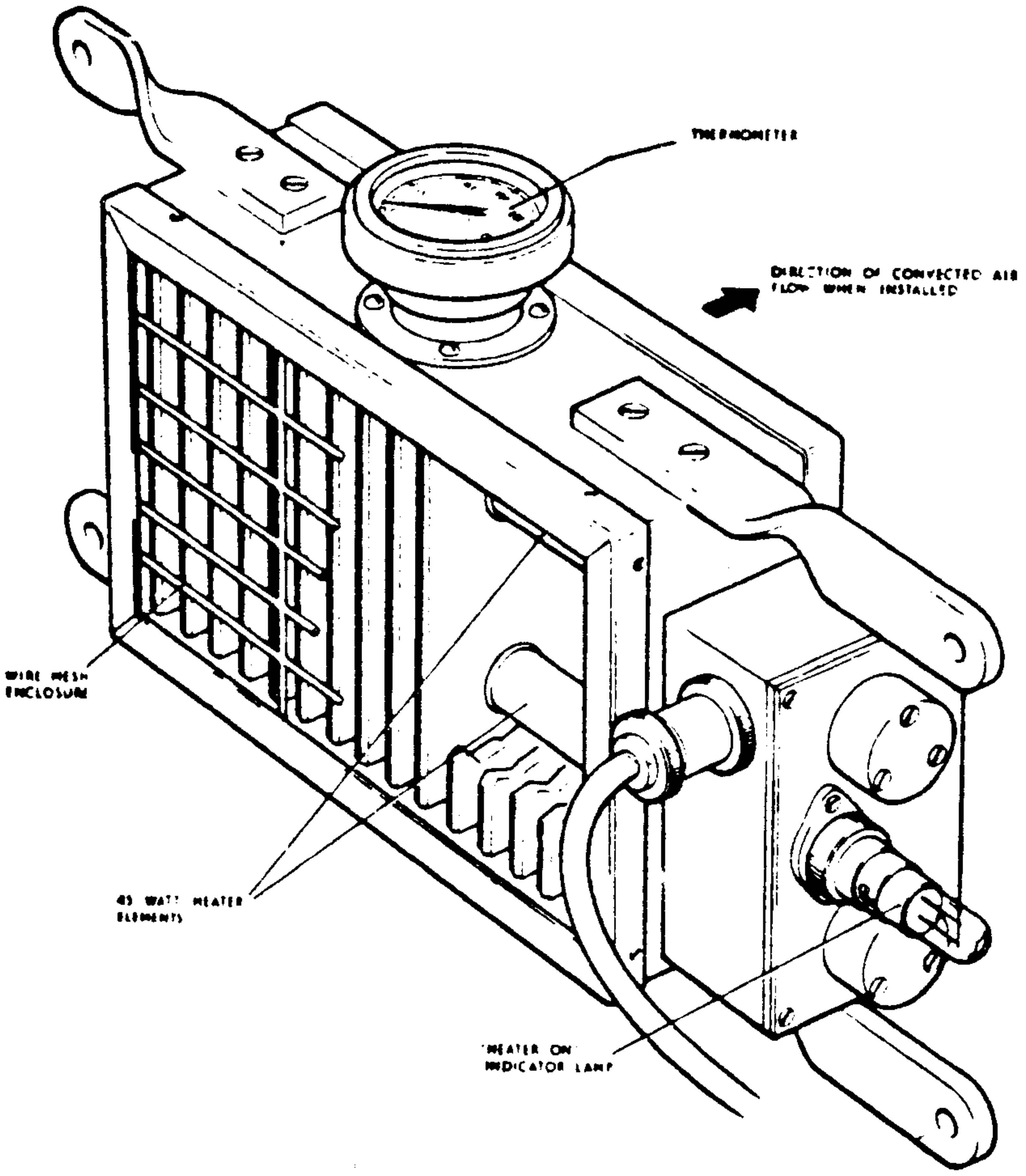
RATES OF CHARGE

Starting Rate (Specific gravity 1.200 or lower)	1800A
Starting Rate (Specific gravity above 1.200)	1400A
Intermediate Rate	900A
Specified Finishing Rate	280A

NOTES 1. The above capacities will be obtainable with electrolyte of corrected specific gravity 1.287 to 1.292 and an initial temperature of 25° C for rates up to and including the 10-hour rate. For rates longer than the

10-hour rate, eg 20-hour rate, the capacities listed are for an end-of-discharge temperature of 25°C.

2. The designed finishing rate is 310A. This charging rate gives increased hydrogen evolution which could exceed the clearing capabilities of the battery ventilation system and must not be used unless authorised by the Ministry of Defence (PE) Sea Systems Controllerate.



HYDROGEN ELIMINATOR

48. Hydrogen Eliminators

All hydrogen eliminators are to be switched on at all times.
The hydrogen eliminators are used to dissipate hydrogen gas in the submarine.

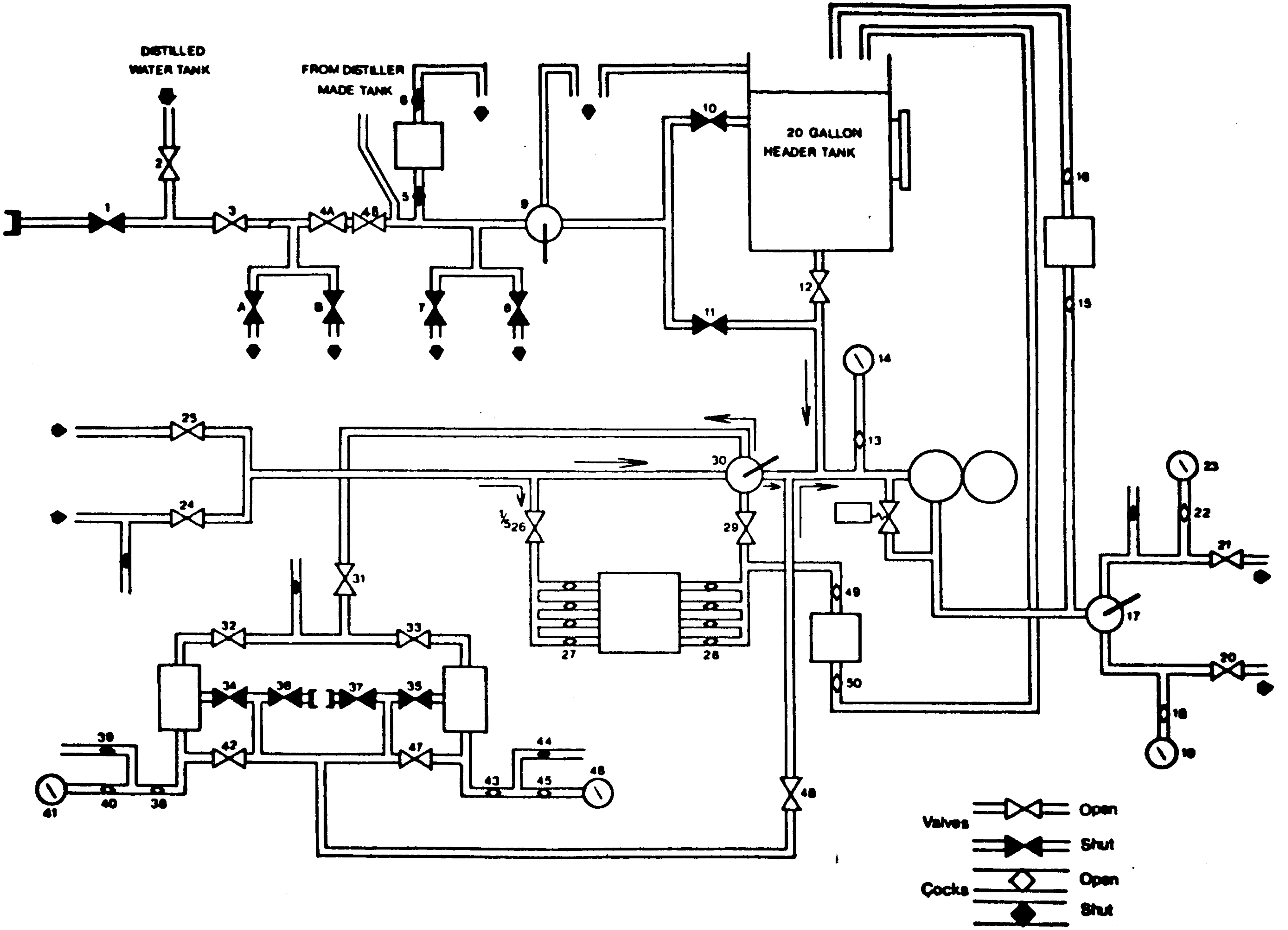
They are fitted throughout the submarine at points where H2 has or is likely to gather. The eliminators consist of a Palladium Catalyst which produces a change in a chemical without changing itself.

It combines the oxygen in the atmosphere with the hydrogen, thus producing a water vapour, a heating element dries off this vapour.

The temperature off all hydrogen eliminators are to be taken at half hourly intervals until half an hour after the completion of a charge.

The sailor checking the state of the battery when on charge is to check the temperatures of the eliminators before the gassing point is reached and then half hourly until the charge is complete.

A net rise of 20° F above the pre-gassing figure will indicate an unacceptable concentration of hydrogen in the vicinity of that eliminator.


DISTILLED WATER TANK
FROM DISTILLER MADE TANK
20 GALLON HEADER TANK
4A
4B
A
B
1/5 26
Valves
Open
Shut
Cocks
Open
Shut

BATTERY COOLING VALVES

1. HOSE CONNECTION VALVE
2. DW TANK TOP VALVE
3. DW LINE STOP VALVE
4. 49 BULKHEAD STOP VALVE
5. NO. 2 SALINOMETER STOP COCK
6. NO. 2 SALINOMETER STOP COCK
7. NO. 2 BATTERY TOPPING UP STOP VALVE
8. NO. 2 BATTERY TOPPING UP STOP VALVE
9. TWO POSITION COCK
10. HEADER TANK FILLING VALVE
11. HEADER TANK BY-PASS VALVE
12. HEADER TANK DISCHARGE VALVE
13. PUMP VACUUM GAUGE STOP COCK
14. PUMP VACUUM GAUGE 30" Hg TO 30 PSI
15. NO. 1 SALINOMETER STOP COCK
16. NO. 1 SALINOMETER STOP COCK
17. PROPORTIONING COCK
18. PRESSURE GAUGE STOP COCK
19. PRESSURE GAUGE 0-60 PSI
20. NO. 1 BATTERY BULKHEAD STOP VALVE (PRESSURE)
21. NO. 2 BATTERY BULKHEAD STOP VALVE (PRESSURE)
22. PRESSURE GAUGE STOP COCK
23. PRESSURE GAUGE 0-60 PSI
24. NO. 2 BATTERY BULKHEAD STOP VALVE (RETURN)
25. NO. 1 BATTERY BULKHEAD STOP VALVE (RETURN)
26. PURIFIER PRESSURE LINE STOP VALVE
27. PURIFIER STOP COCKS
28. PURIFIER STOP COCKS
29. PURIFIER RETURN LINE STOP VALVE
30. PROPORTIONING COCK
31. HEAT EXCHANGER SLUICE VALVE
32. HEAT EXCHANGER HULL VALVE (PRESSURE)
33. HEAT EXCHANGER HULL VALVE (PRESSURE)
34. HEAT EXCHANGER HULL VALVE (DRAIN OFF)
35. HEAT EXCHANGER HULL VALVE (DRAIN OFF)
36. HOSE CONNECTION DRAIN OFF VALVE
37. HOSE CONNECTION DRAIN OFF VALVE
38. HULL COCK (EXTERNAL PRESSURE GAUGE)
39. DRAIN COCK (EXTERNAL PRESSURE GAUGE)
40. STOP COCK (EXTERNAL PRESSURE GAUGE)
41. EXTERNAL PRESSURE GAUGE 0-400 PSI
42. HEAT EXCHANGER HULL VALVE (RETURN)
43. HULL COCK (EXTERNAL PRESSURE GAUGE)
44. DRAIN COCK (EXTERNAL PRESSURE GAUGE)
45. STOP COCK (EXTERNAL PRESSURE GAUGE)
46. EXTERNAL PRESSURE GAUGE 0-400 PSI
47. HEAT EXCHANGER HULL VALVE (RETURN)
48. HEAT EXCHANGER SLUICE VALVE
49. NO. 3 SALINOMETER STOP COCK
50. NO. 3 SALINOMETER STOP COCK

A. NO. 1 BATTERY TOPPING UP STOP VALVE
B. NO. 1 BATTERY TOPPING UP STOP VALVE

EACH BATTERY HAS SIX COOLING VENTS:

NO. 1	NO. 2
4 IN SENIOR RATES MESS	4 OUTSIDE WARDROOM
1 IN FORWARD MESS	1 IN STEWARDS' PANTRY
1 IN CUPBOARD OUTSIDE GALLEY	1 IN AMS BY COOLING HEADER TANK

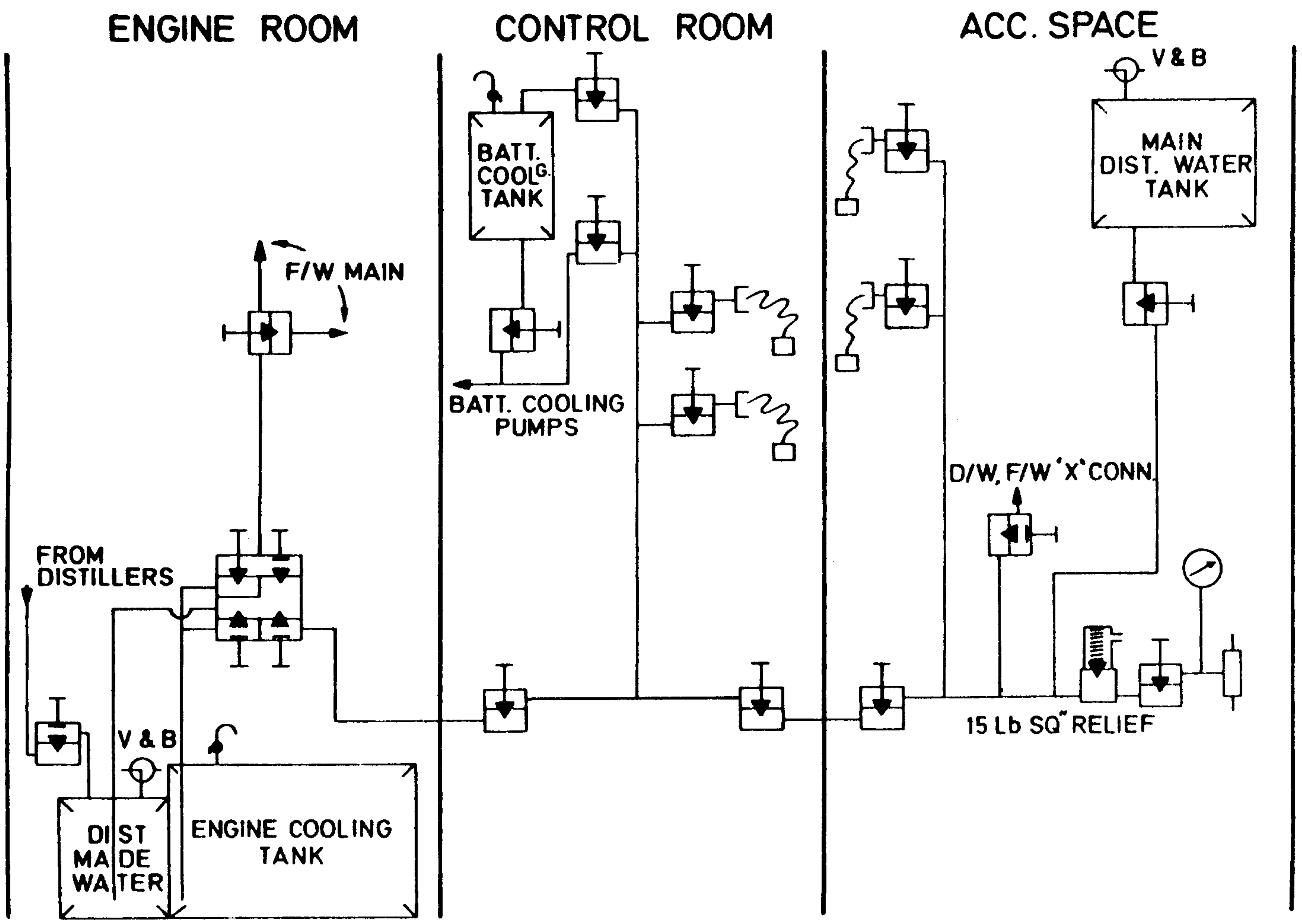


Fig. 4 DISTILLED WATER SYSTEM

49. BATTERY COOLING

Heat is generated in the cells of a main battery by charges and discharges. Discharges in excess of the six hour rate cause an increase in temperature and any rate of charging will increase cell temperature. However, discharges at a lesser rate than six hours will tend to reduce the cell temperature.

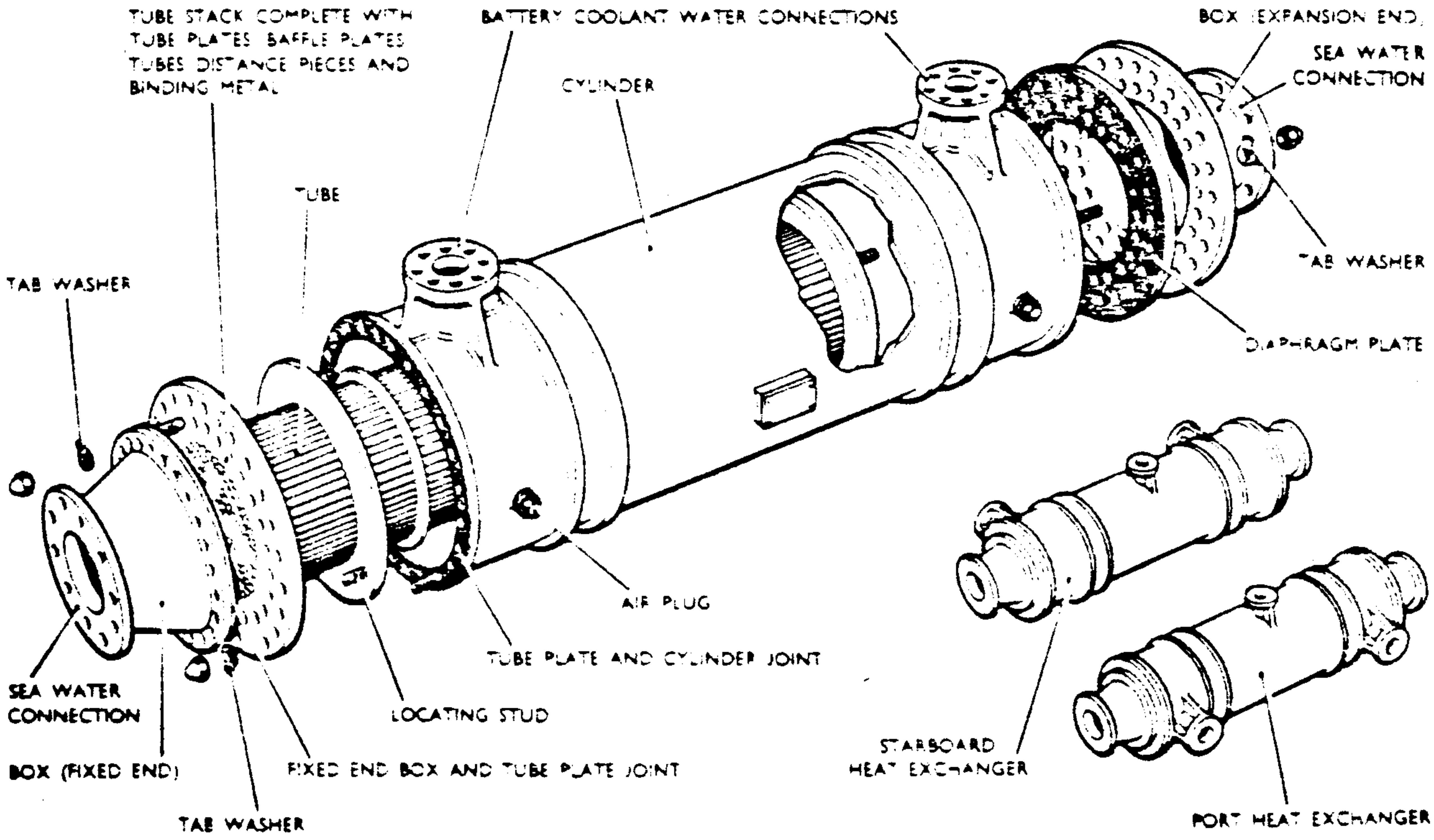
50. Cooling - General Arrangement

The battery cooling system is provided to dissipate the heat generated in the battery cells when they are being charged. The system is a closed circuit distilled water, circulating cooling system. Water is pumped by one circulating pump into the battery compartment supply line and then delivered to the tops of all cells by means of ducts secured around the cell terminals. The coolant now returns to the return line back to the pump in three ways:

a. via heat exchangers;

b. via purifiers; and

c. direct to the pump.



Heat Exchanger - Battery Cooling System

51. Times to Run Battery Cooling

The battery cooling system is provided to dissipate the heat generated in the battery cells when they are being discharged at a high rate, or when being charged as follows:

a. During high rate discharges.

b. As required to keep battery cool; always run when battery temperature exceeds 95° F.

c. If not in use, run for half an hour daily to avoid stagnation.

52. The Salinometer

The salinometer is an electrical device for measuring impurities in water.

The principle of the salinometer is to pass a current through the water under test, and reading off on a calibrated scale, the purity of the water in UNITS OF CONDUCTIVITY.

If two electrodes are placed in the water to be tested and current is passed from one to the other through the water, the more pure the water, the greater is its resistance, therefore less current will flow. Should the purity of the water deteriorate, the resistance will decrease, and more current will flow between the electrodes. The amount of current is measured on a meter in the circuit, which is calibrated in UNITS OF CONDUCTIVITY.

The electrodes are contained in a glass tube, fitted with a supply line and cock, an outlet line and cock, a vent plug and terminals. The whole unit is known as the SALINOMETER CELL.

The remainder of the components, except for the switch, power on lamp, red warning lamp and the meter, are contained in a metal box, which is situated in the AMS, close to its associated salinometer cell.

A box containing the switch, the meter and two lamps is situated in the control room to engine room passage.

The relays are fitted; J1 to operate a contact to light the red warning light and operate a contact in each of the control circuits for the battery cooling pump starters; this stops the pumps if the water reaches 20 cu. J2 operates a contact to short out the indicator if the water reaches 40 cu.

J1 = 20 cu. J2 = 40 cu.

Three salinometers are fitted:

a. Number 1. Salinometer cell is fitted into the distilled water circuit which runs round the battery cooling, to measure the purity of the water in contact with the battery. It is to be found in the AMS (this salinometer controls the battery cooling pump).

b. Number 2. Salinometer cell is fitted into the distilled water line, from the main storage tank, to check the purity of the water coming from the tank to whichever service we wish to use, i.e. topping up, replenishing, cooling system, etc. Again the cell is in the AMS, close to its associated components. The switch, the meter and both lamps are the same as used for No. 1. This is achieved by means of a COS marked No. 1 salinometer/No. 2 salinometer.

c. Number 3. Salinometer cell is fitted in the purifier line of the battery cooling system. It is sometimes referred to as the FINE READING SALINOMETER. No. 3 is only fitted to check the purifiers are working correctly and are not becoming exhausted. Normally checked every two hrs This time the salinometer cell, the components and the switch, meter and lamps are all situated in the AMS. No. 3 salinometer should never be left switched on.

The red warning lamp operates at 4 cu and the indicator is shorted at 5 cu.

No. 1 and No. 2 reads from 0-50 cu.

No. 3 reads from 0-5 cu.

NOTE: ALL THE TIME BATTERY COOLING IS RUNNING, NO. 1 SALINOMETER MUST REMAIN SWITCHED ON. CHECK THAT THE COS IS TO NO. 1 SALINOMETER.

53. To Open Up and Run the System

a. Check that the two sluice valves at 49 bulkhead and the four sluice valves on the fwd AMS bulkhead are open.

b. Check that the valves to the heat exchangers are open.

c. Check that the gravity tank is at least 2/3 full, and open the supply valve from the tank to the pump suction.

d. Check that the heat exchanger proportioning cock is set to the required position.

e. Check the supply to, and return from the purifier valves are open.

f. Check that No. 3 salinity cell isolating cocks are shut.

g. Run the pump.

h. Check the pump discharge and suction gauges (normal readings 12-13 psi discharge and 4 psi suction).

i. Check that the level in the gravity tank is at least ¼ full.

j. Check that No. 1 salinometer cell is reading less than three units. If greater than three units, inform WEEO.

k. Check that the distant reading salinity unit isolating switch is ON, so that a reading in excess of 20 units will automatically stop the pump.

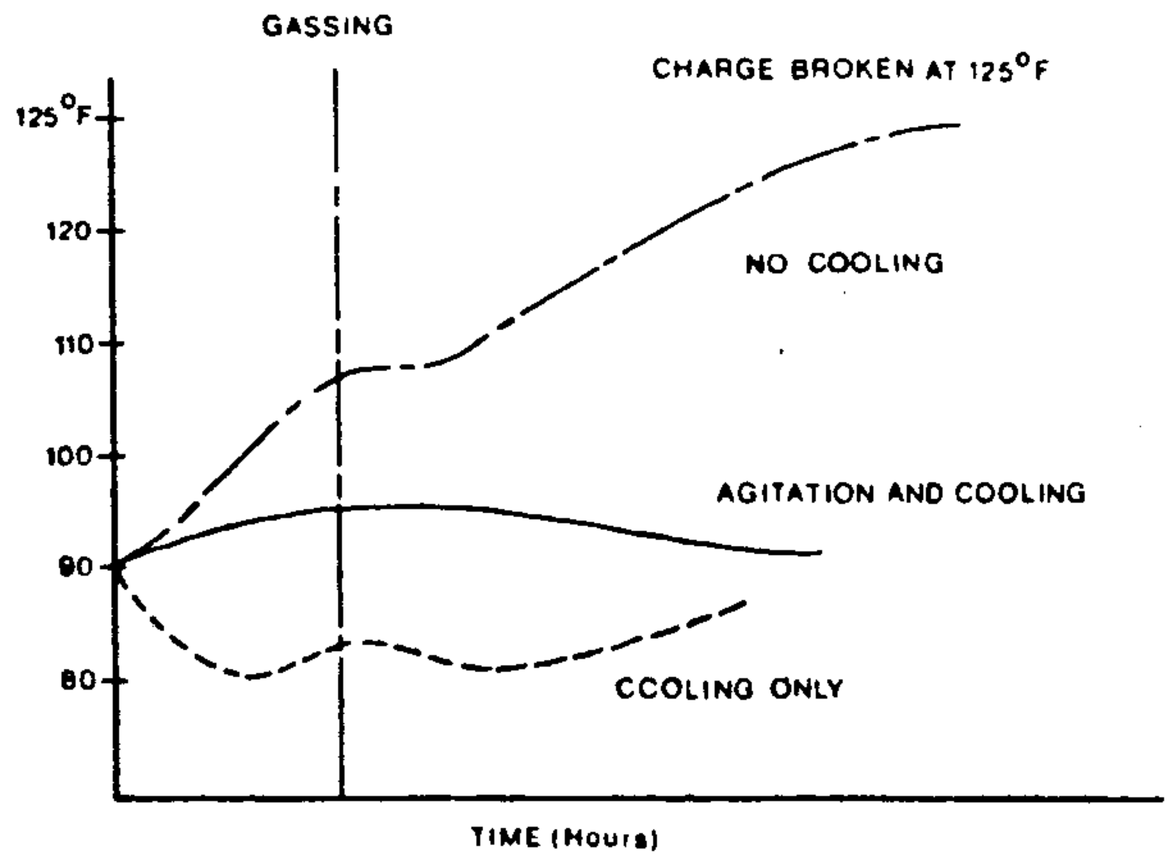
NOTE: When shutting off for attack, the heat exchanger hull valves will be shut. If the system is running, ensure that the heat exchanger proportioning cock is to 100% recirculation, before shutting the hull valves.

54. To Shut Down the System

a. Stop the pump.

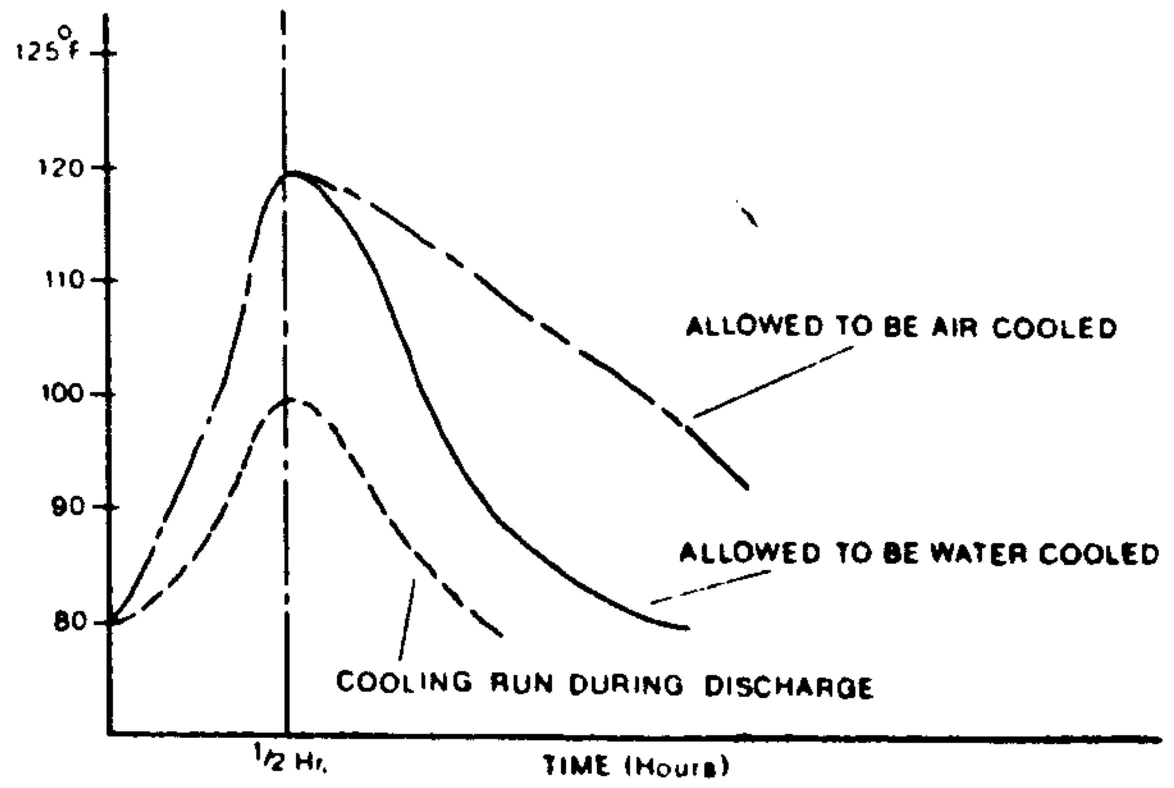
b. Shut supply from the gravity tank to pump suction.

c. Shut off the supply cock to No. 1 salinometer.



EQUALISING CHARGE

COOLING CONDITIONS DURING CHARGE AND DISCHARGE



CELL DISCHARGED AT THE 8 HOUR RATE

55. Embarking Distilled Water

Connect the hose from shore to the hose connection at the for'd end of the accommodation space, having first flushed through the hose. Check that the tank top valve is shut, bulkhead stop valve open, FW/DW cross-connection shut, topping up valves shut and control room/engine room bulkhead stop valve is shut. Open No. 2 salinometer and switch "ON" the salinometer. Open the hose connection valve and have water turned on at source.

Water will now flow through the line to No. 2 salinometer and drain into AMS bilge. If the distilled water reading is 8 conductivity units or less, the water is acceptable. Open tank top valve and put vent and blow to vent; shut salinometer cocks and switch off the salinometer. While the distilled water tank is filling, a close watch must be kept on the dip-stick.

As the tank reaches FULL, have the water turned off at source; most of the water in the hose can then drain into the tank. Shut hose connection valve, tank top valve and screw dip-stick well home.

The NORMAL position of the valves on the distilled water line are:

a. Hose connection valve shut.

b. Tank top valve shut.

c. FW/DW cross-connection shut.

d. Topping up valves shut.

e. Bulkhead stop valves open.

f. No. 2 salinometer cocks shut.

g. Three position cock shut.

h. Control room/engine room bulkhead stop valve shut.

"Now come on, somebody must know what this is!"

56. Battery Ventilation

A 4% concentration of hydrogen gas in air constitutes an explosive mixture and merely requires some form of ignition to create an explosion.

Without battery ventilation running during a charge, a 2% concentration in the battery tank or compartment is reached within 34 seconds of the battery starting to gas i.e. reaching 538 volts. Gassing continues until the end of the charge and only ceases when the voltage has fallen below 538 volts. Even at this stage there may be a large amount of gas left in the tank or compartment, thus the ventilation must be left running for at least 5 minutes after this figure has been reached and preferably for one hour. Detailed instructions for the correct operation of the battery ventilation system are contained in BR 2075X and Techaddenda No. 29 and must be strictly adhered to.

57. RAN OBERON Class Battery Ventilation

The purpose of the battery ventilation system is to extract gasses from battery compartments during charging. The drill for opening up and running battery ventilation is as follows:

a. Check that the Bellmouth flaps in the AMS are open.

b. Check that suction flaps from "S" tank are shut and pinned.

c. Check that No. 2 battery ventilation isolating flap in the AMS is open. (FIRE FLAP)

d. Check that the ball valves on 49 and 77 bulkheads are open.

e. Stop H2 fans and shut inlet and outlet flaps (three in number for each battery).

f. Start battery fans.

g. Check inlets for suction.

h. Check fans and running lights.

i. Check discharge in engine room.

j. Check ventilation flow indicator in the motor room & the VP earth meters.

In an emergency, only one battery fan may be used in the event of a failure of the other fan; run as above. Under no circumstances must the battery voltage exceed 500 volts. Should the battery voltage exceed 520 volts accidently, the generator breakers must be tripped IMMEDIATELY.

58. Venting Outboard (in Harbour Only)

a. Rig the portable trunking from battery vent exhaust, via the engine room hatch.

b. Ensure that the outboard end of the portable trunking is pointing downwind.

c. Ensure that at least one other pressure hull hatch other than the tower and engine room hatches are open. All bulkhead doors are to be open.

d. Run battery ventilation as above.

59. Ventilation Between Charges

a. Battery ventilation intakes in AMS are open.

b. H2 inlets and outlets open (six in number flaps).

c. 49 and 77 bulkhead stop valves open.

d. H2 clearing fans running (switches on OOW panel in control room).

e. All H2 eliminators switched on.

f. Ship's ventilation running as required.

NOTES: During all charges the battery hatches are to be shut. They are only to be opened to permit entry and exit of personnel for essential purposes. The duration of time the hatches are kept open should be kept to an absolute minimum.

60. Rules for Running Battery Ventilation

Precise rules for running battery ventilation are contained in RANSSOs and Tech Addenda. The following extracts should only be used as a guide:

a. The main battery will be ventilated outboard in harbour and inboard at sea.

b. When charging in harbour the tower hatch and one other hatch must be open.

c. At all times whilst charging, the ship's ventilation must be running to assist the circulation of air in the submarine.

d. Whenever main battery fans have been started, all intakes are to be checked for airflow with periscope paper or similar light material.

e. If the batteries are to be connected to the generators for floating or charging, the battery fans are to be run at least five minutes before connection and are to be left running for at least five minutes and preferably one hour after completion of the charge.

Harbour Stations. It is not necessary to shut down the ventilation system at this stage (if running) all orders regarding ventilation will come from the control room.

Standby to Snort. When the order "Standby to Snort" is given, the motor room will be ordered to open up and run battery ventilation.

Stop Snorting. Unless specifically ordered, the battery ventilation must be shut down.

Working on Main Batteries. The battery ventilation system should be running when any maintenance or repair work is being done in the battery compartments.

61. Times to Run Battery Ventilation.

a. Five minutes prior to charging

b. Whenever charging

c. If possible for one hour after a gassing charge

d. Whenever personnel are working in the battery compartment

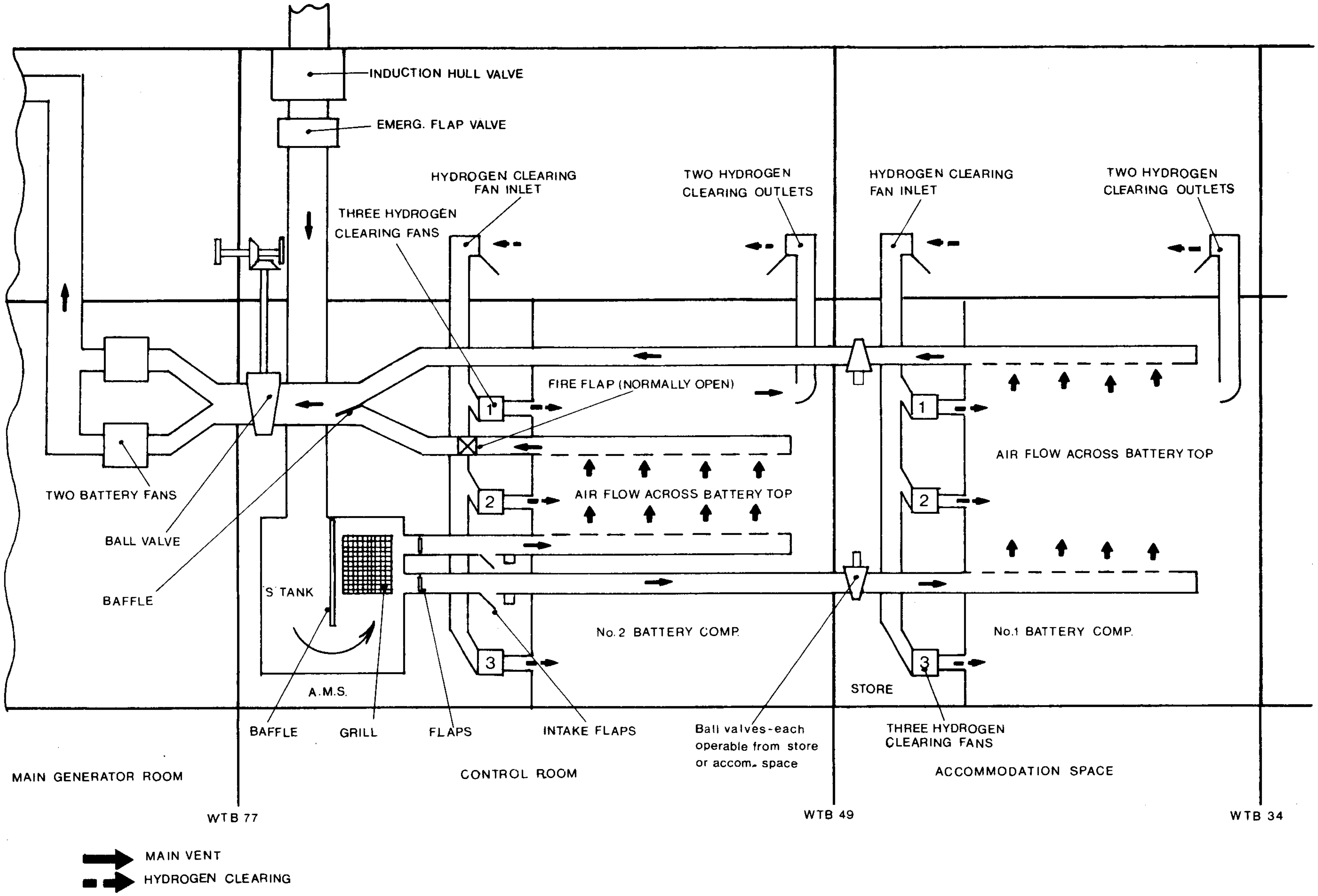
e. Prior to harbour stations

f. For smoke clearance

g. OTTO Fuel emergency

h. Twice daily in harbour (morning and evening for one hour)

i. As required to keep the battery cool


INDUCTION HULL VALVE
EMERG. FLAP VALVE
HYDROGEN CLEARING FAN INLET
THREE HYDROGEN CLEARING FANS
TWO HYDROGEN CLEARING OUTLETS
HYDROGEN CLEARING FAN INLET
TWO HYDROGEN CLEARING OUTLETS
FIRE FLAP (NORMALLY OPEN)
AIR FLOW ACROSS BATTERY TOP
AIR FLOW ACROSS BATTERY TOP
1
2
3
1
2
3
TWO BATTERY FANS
BALL VALVE
BAFFLE
'S TANK
A.M.S.
No. 2 BATTERY COMP.
No.1 BATTERY COMP.
STORE
BAFFLE
GRILL
FLAPS
INTAKE FLAPS
Ball valves-each operable from store or accom. space
THREE HYDROGEN CLEARING FANS
MAIN GENERATOR ROOM
CONTROL ROOM
ACCOMMODATION SPACE
WTB 77
WTB 49
WTB 34
MAIN VENT
HYDROGEN CLEARING

TWO FAN SYSTEM FOR OBERON CLASS

SECTION II

OPERATION AND DETAIL

1. Introduction

During the week, you have been learning about submarine main batteries, from the build-up of a cell to the layout of the battery compartments.

The two battery sections are situated in separate compartments; each section is provided with its own battery switchboard, which is sited in the compartment above the battery section. Each battery switchboard is provided with means of connecting its associated battery for charge and discharge and enabling it to be connected to the main power bus-bars, and/or supply power to the auxiliary power bus-bars.

Each battery can be divided into two half sections by the opening of a battery mid-point link switch, so enabling the battery sections to be charged from shore at half the nominal battery voltage. Opening this switch also allows No. 1 battery to supply the submarine's constant pressure (CP) ring main at half the norminal battery voltage.

The two batteries may be grouped in series or parallel, to give a nominal voltage of 880 or 440 across the main power bus-bars.

A simplified layout of the equipment fitted in OBERON class submarines is shown in general layout. The chief items of equipment are:

a. Two main diesel-driven generators, which supply power to the propelling motors and the auxiliary services.

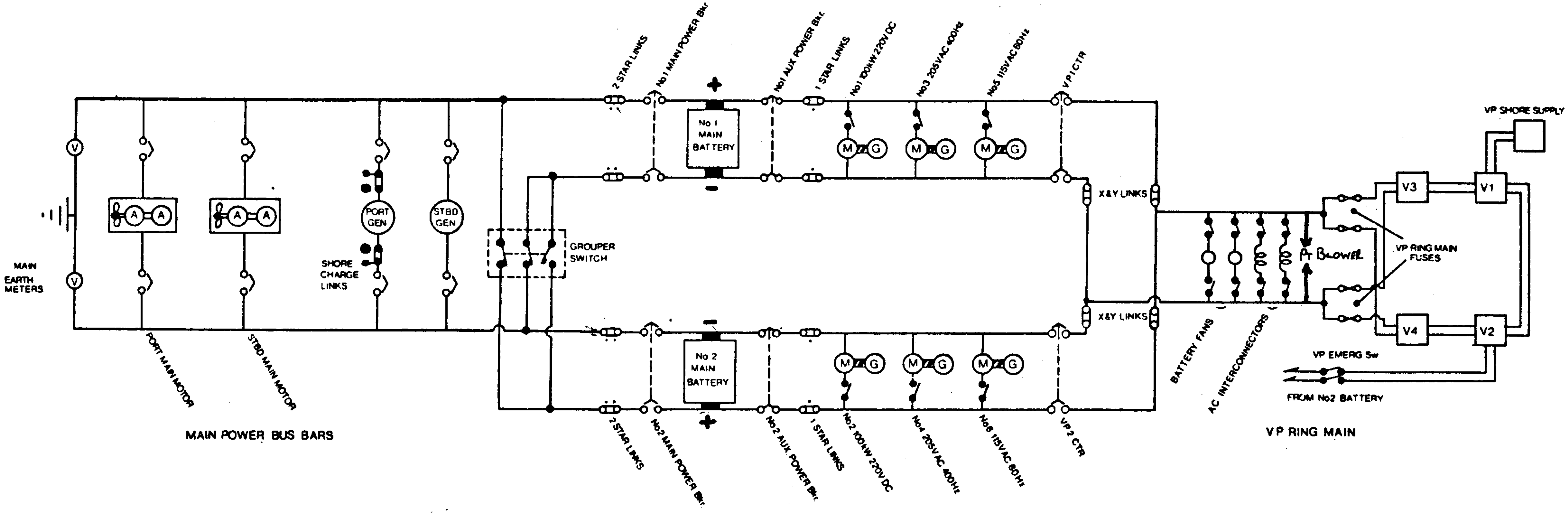
b. Two main batteries arranged in two sections, to supply power as in a. above.

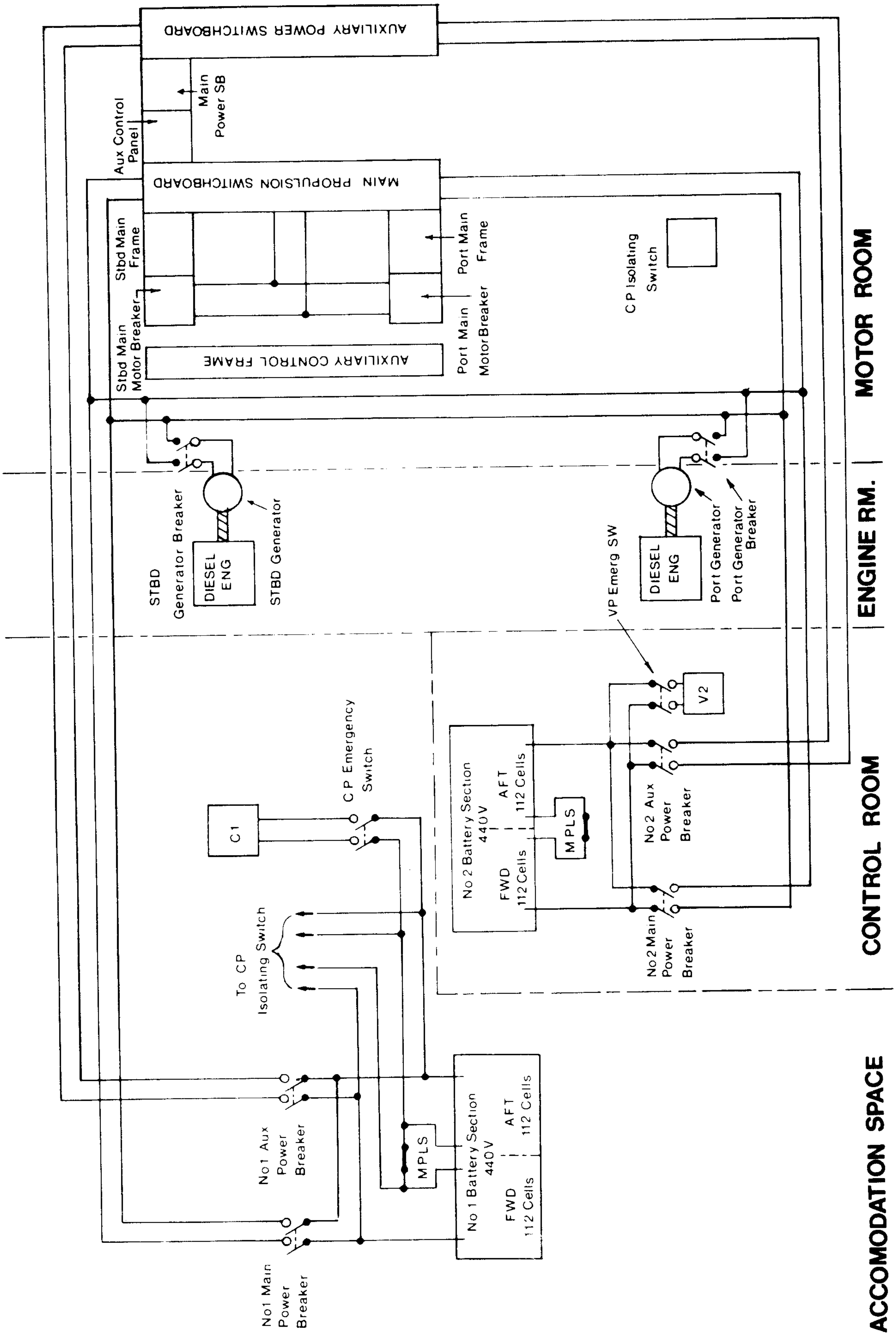
c. Four main propelling motors arranged for operation in pairs. Each pair of motors is built directly on a single shaft, which forms a portion of the propelling shaft line.

d. A switchboard which can connect the above equipment to propel the submarine by the following methods:

    (1) Battery power when submerged.

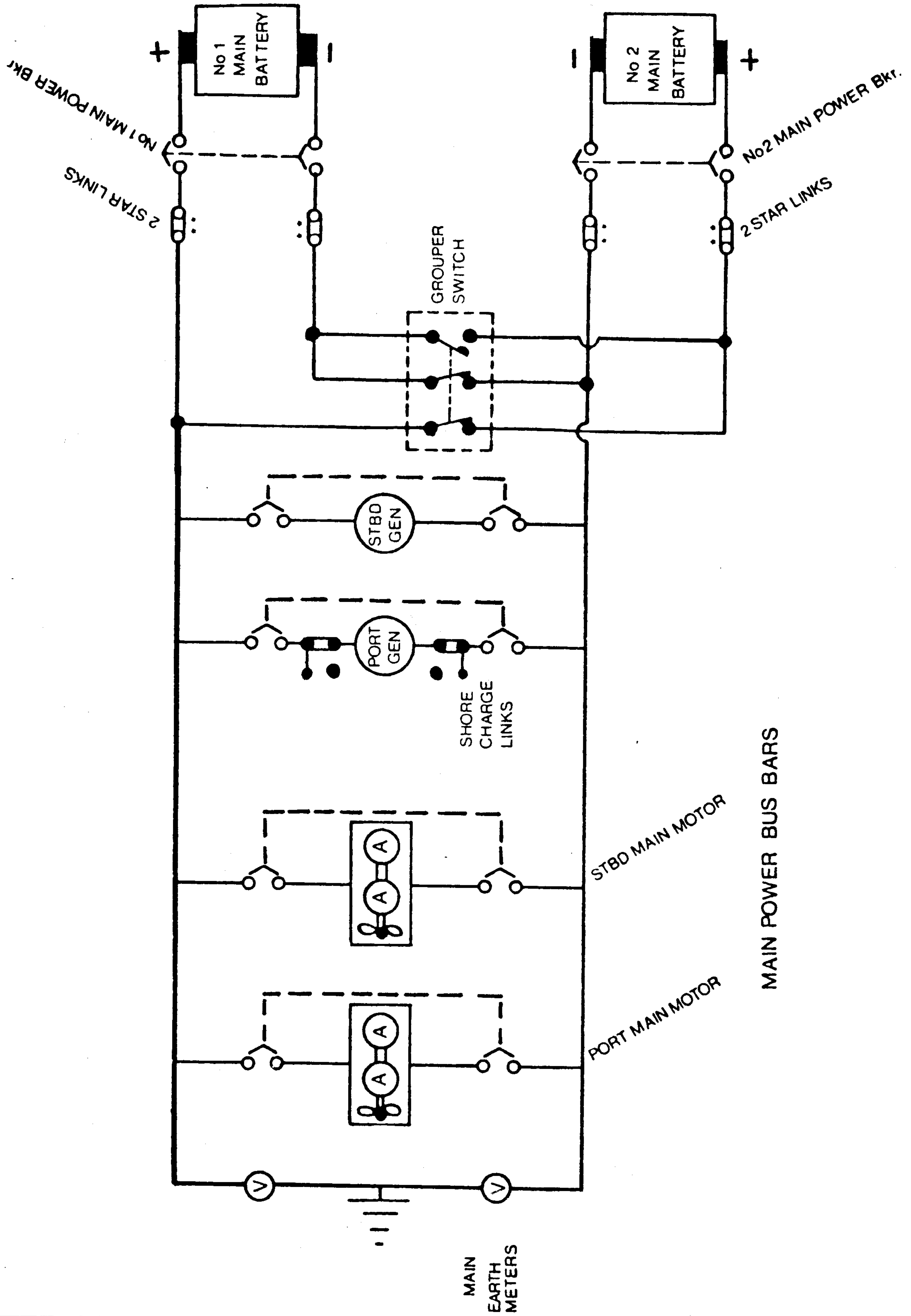
    (2) Diesel electric power when snorting or on the surface.


MAIN POWER BUS BARS
VP RING MAIN
MAIN EARTH METERS
V
PORT MAIN MOTOR
STBD MAIN MOTOR
A
PORT GEN
STBD GEN
SHORE CHARGE LINKS
GROUPER SWITCH
2 STAR LINKS
No 1 MAIN POWER Bkr
No 1 MAIN BATTERY
No1 AUX POWER Bkr
1 STAR LINKS
No1 100kW 220V DC
No3 205VAC 400Hz
No5 115VAC 60Hz
VP 1 CTR
2 STAR LINKS
No2 MAIN POWER Bkr
No 2 MAIN BATTERY
No 2 AUX POWER Bkr
1 STAR LINKS
No2 100kW 220V DC
No4 205V AC 400Hz
No6 115VAC 60Hz
VP 2 CTR
M
G
X&Y LINKS
X&Y LINKS
BATTERY FANS
AC INTERCONNECTORS
AT BLOWER
VP RING MAIN FUSES
V1
V2
V3
V4
VP SHORE SUPPLY
VP EMERG Sw
FROM No2 BATTERY

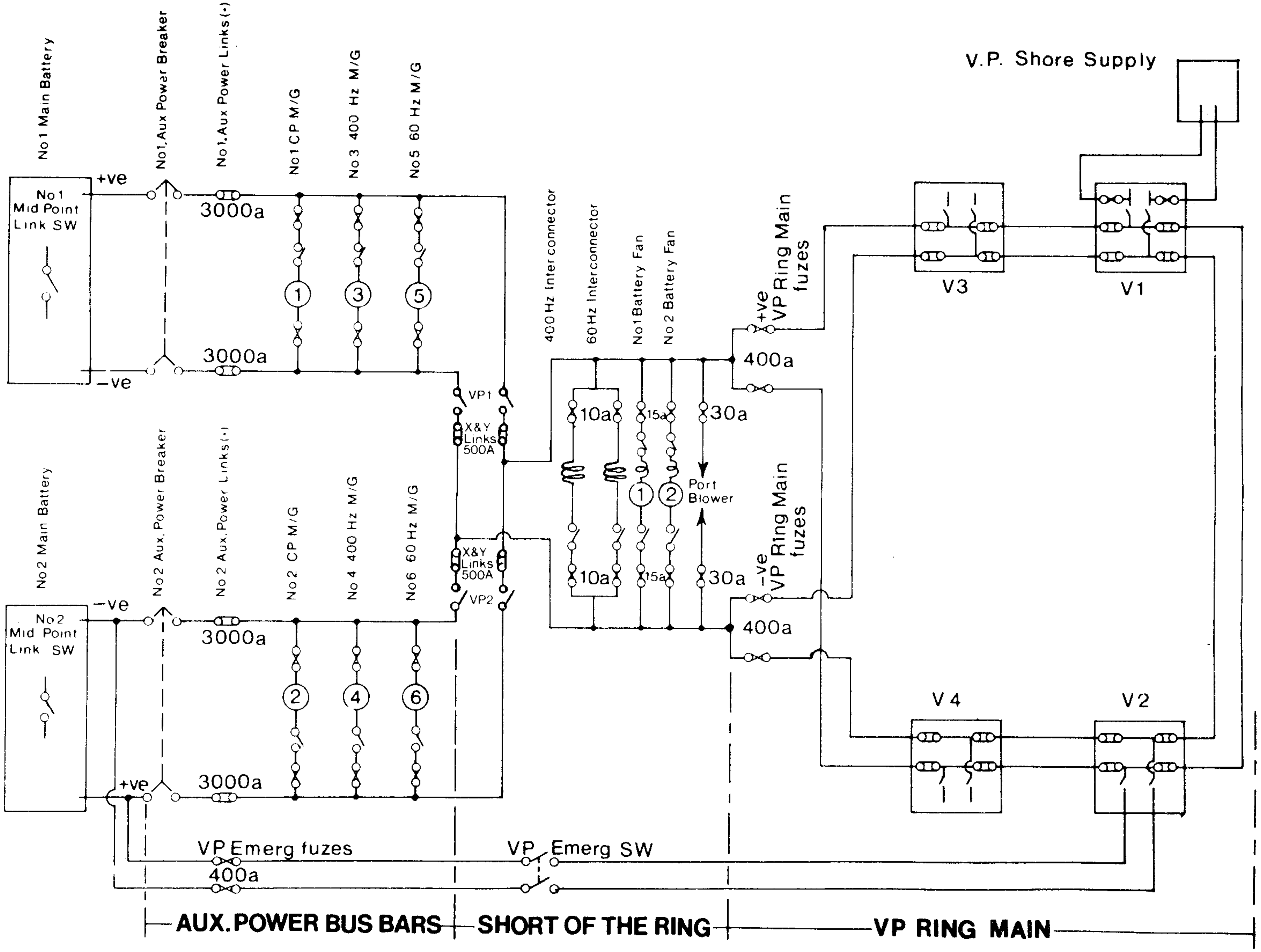


GENERAL ELECTRICAL LAYOUT

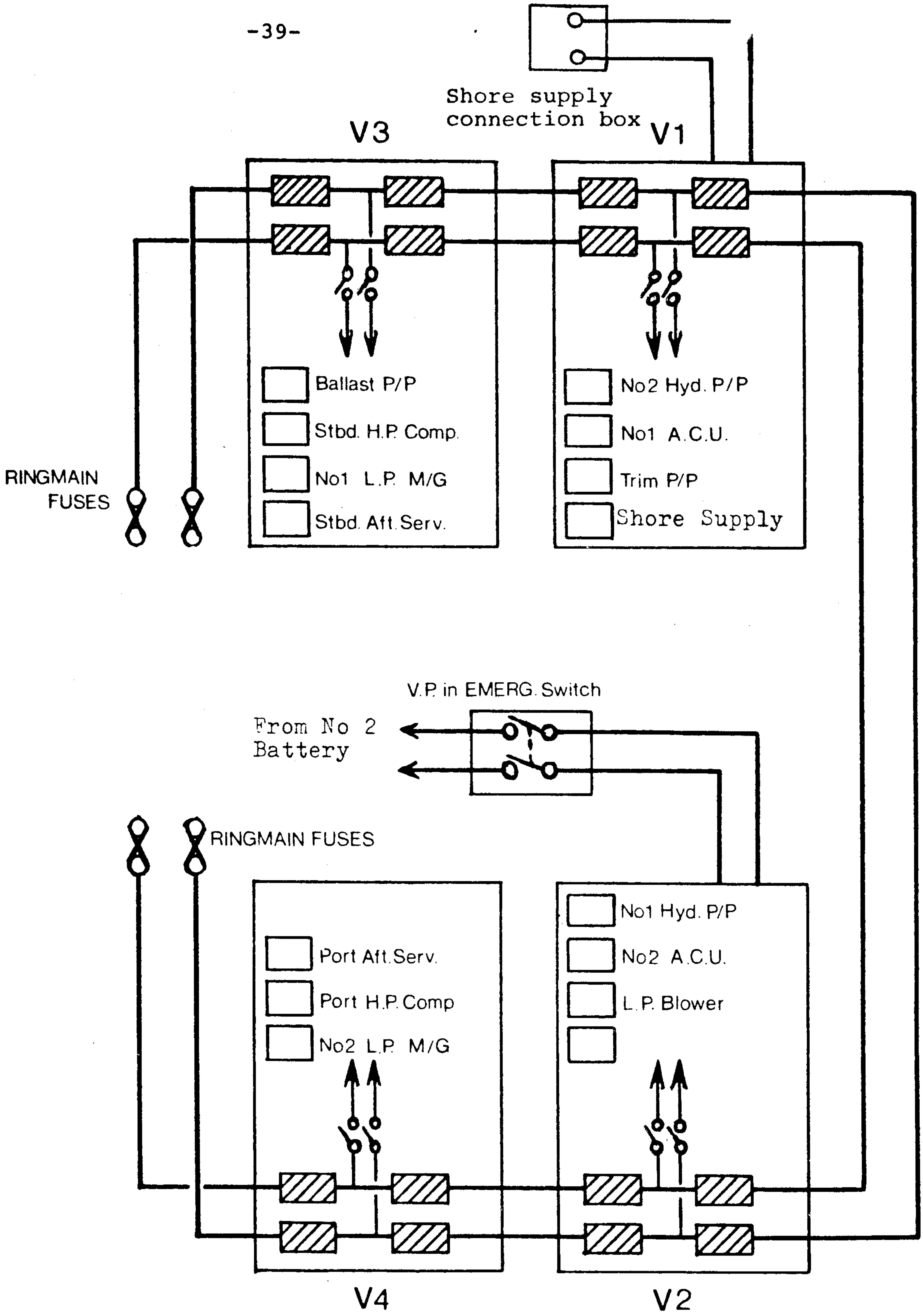
Fig. 2-4



MAIN POWER BUS BARS



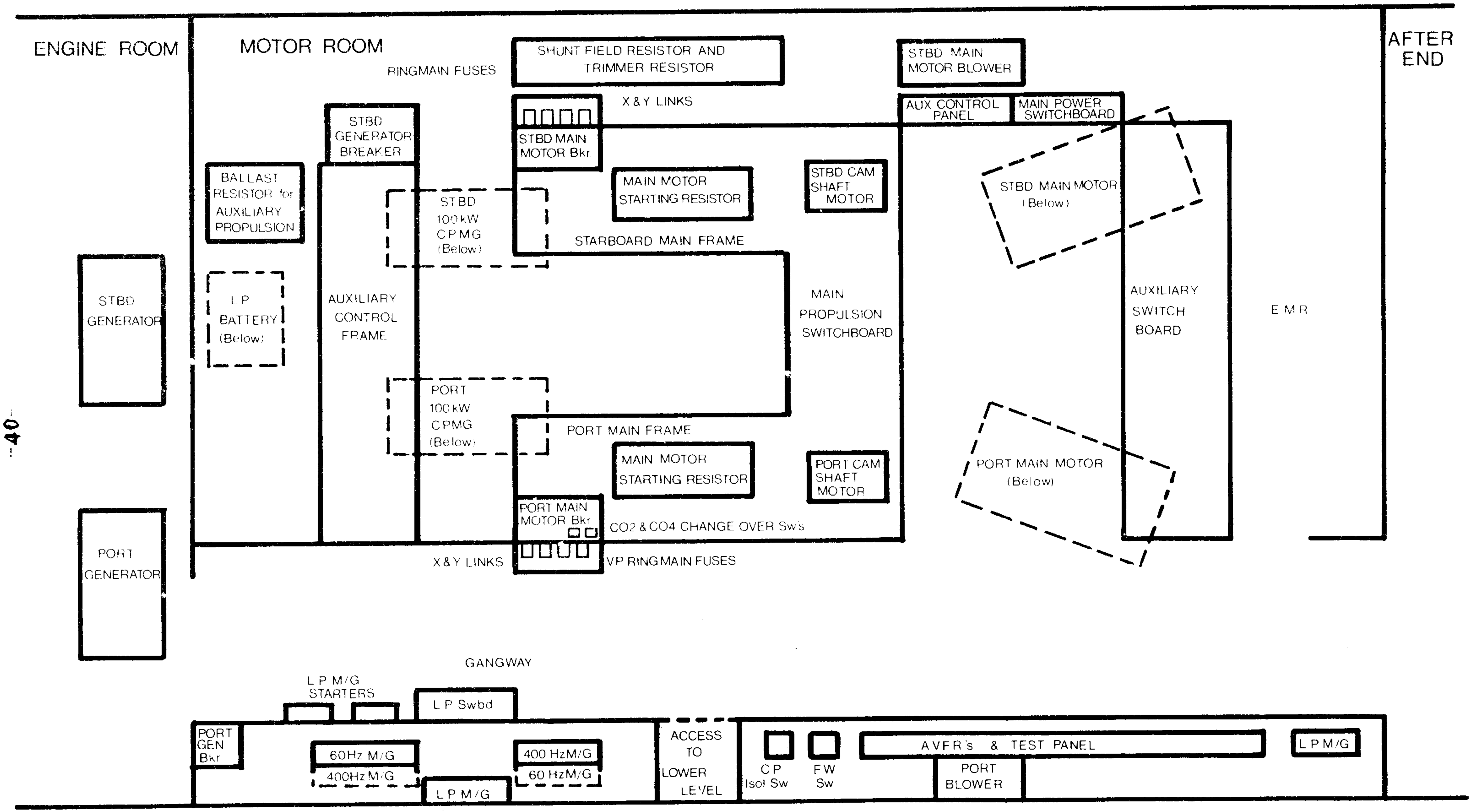
AUXILIARY POWER & V.P. SYSTEMS



Note

a) On Otama No.1 Hydraulic pump is fed from V1 and No.2 Hydraulic pump is fed from V2.

b) On Otama and Orion the Trim pump is fed fromV2 not V1.



OBERON CLASS LAYOUT OF MOTOR ROOM
(Not to scale)

2. Motor Room Layout

Propulsion and auxiliary equipment is controlled from switchboards grouped around the operator's cubicle. They comprise the following:

a. Main Propulsion Switchboard

Main motors.

b. Main Power Switchboard

Main battery charging.

c. Auxiliary Power Switchboard

Conversion machinery.

d. Auxiliary Control Panel

Battery fans, blowers, and temperature gauges.

e. Auxiliary Control Frame

Conversion machinery supply fuses and contactors.

f. Port Main Frame/Starboard Main Frame

Main motor control switchgear.

3. Battery Switchboard

Each battery is provided with its own battery switchboard, sited as follows:

No. 1 starboard side of accommodation space

No. 2 port side of control room, outside the wardroom.

Both contain the following equipment:

a. Main power breaker.

b. Auxiliary power breaker.

c. Battery laying "off" links.

d. Shore charging terminals and link positions.

e. Mid-point link switch.

f. Fuses.

g. Battery ammeter shunt

h. Shore charging ammeters. Main and auxiliary power breaker 15 amp control fuses (fed from live side of battery breaker), 30 amp fuses for battery discharge and charge ammeters. Two 1150 amp fuses for 220 volt shore charges and 5 amp fuses for battery voltmeters.

Other items in the battery switchboards are:

a. No. 1 Battery Switchboard. Carries three sets of 400 amp fuses. These provide alternative 220 V DC supplies for the CP ring main. They are known as CP "A", CP "B" and CP emergency. In addition there is a 60 amp mid-point tapping fuse.

b. No. 2 Battery Switchboard. Carries one pair of 400 amp fuses only, for VP emergency supply.

c. Main Power Breaker. To connect the output of the battery to the main power bus-bars. They are double pole breakers fitted with over current and no volt release. They can be set locally electrically, locally manually, or remotely from the main power switchboard in the motor room.

d. Auxiliary Power Breakers. To connect the output of the battery to the auxiliary power bus-bars. They are fitted with over current and no volt release. They can be operated as for the main power breaker.

e. Battery Laying "Off" Links. Sometimes referred to as the one star and two star links. They are four black screw in links situated in the bottom right of the battery switchboard. They can be used in two positions:

(1) In the lower position they connect the battery to the main power and auxiliary power bus-bars via the main and auxiliary power breakers. This is therefore the NORMAL RUNNING POSITION.

(2) In the upper position they are used for shore charging, all four links being shipped for a 220 volt shore charge, whilst for a 440 volt shore charge the two star (outer) links are shipped, the one star links being laid aside.

4. Mid-Point Link Switch

To split the battery in half whenever work is being carried out on the battery. It will also be opened when:

a. A 220 V DC supply is required to be put on the CP ring main direct from the battery (No. 1 only).

b. When charging either battery from a 220 V DC supply source.

c. Fighting a battery fire.

The mid-point link switches have interlock contacts with their own main and auxiliary power breakers to ensure that the MPLS is closed before the breakers can be set. A set of contacts also actuates indicating lights on the auxiliary power switchboard, for the OPEN and CLOSED positions.

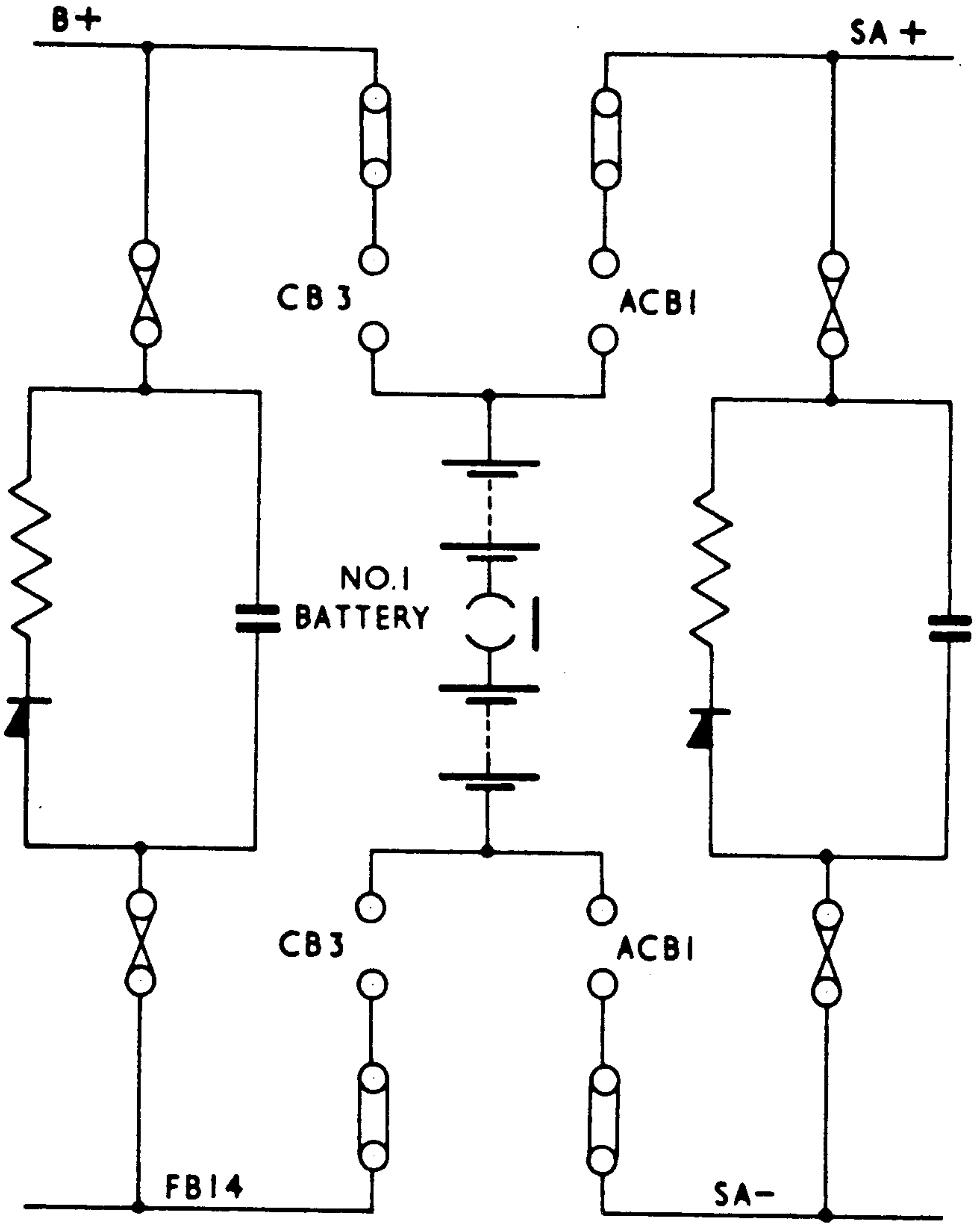
On No. 1 MPLS there are interlock contacts to ensure CP "A" and "B" contactors cannot be made until the MPLS is OPEN.

5. Transient Voltage Suppression

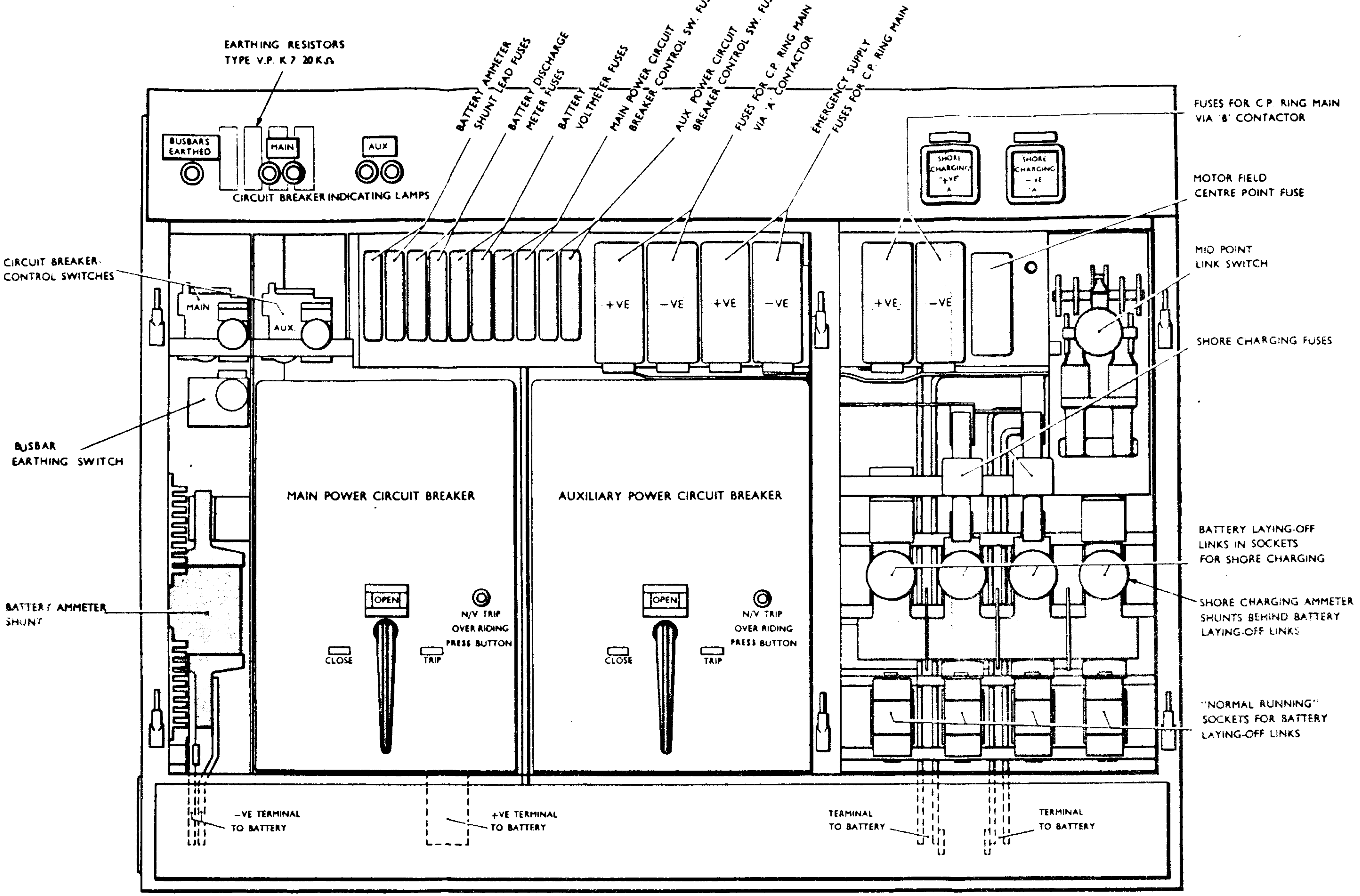
If the propulsion system is not in use, but either one or both Main Power breakers remain set, a small current (1-2 amps) continues to pass in the bus-bars. This current supplies the camshaft motor fields and no-volt release coils on the main motor breakers and bus-bars. When it is broken, on opening the last remaining breaker, the voltage presented across the bus-bars by the collapse of the magnetic fields in these inductive components, can be as high as 5 kV for a few milli-seconds.

6. Transient Voltage Suppression (No. 1 Battery)

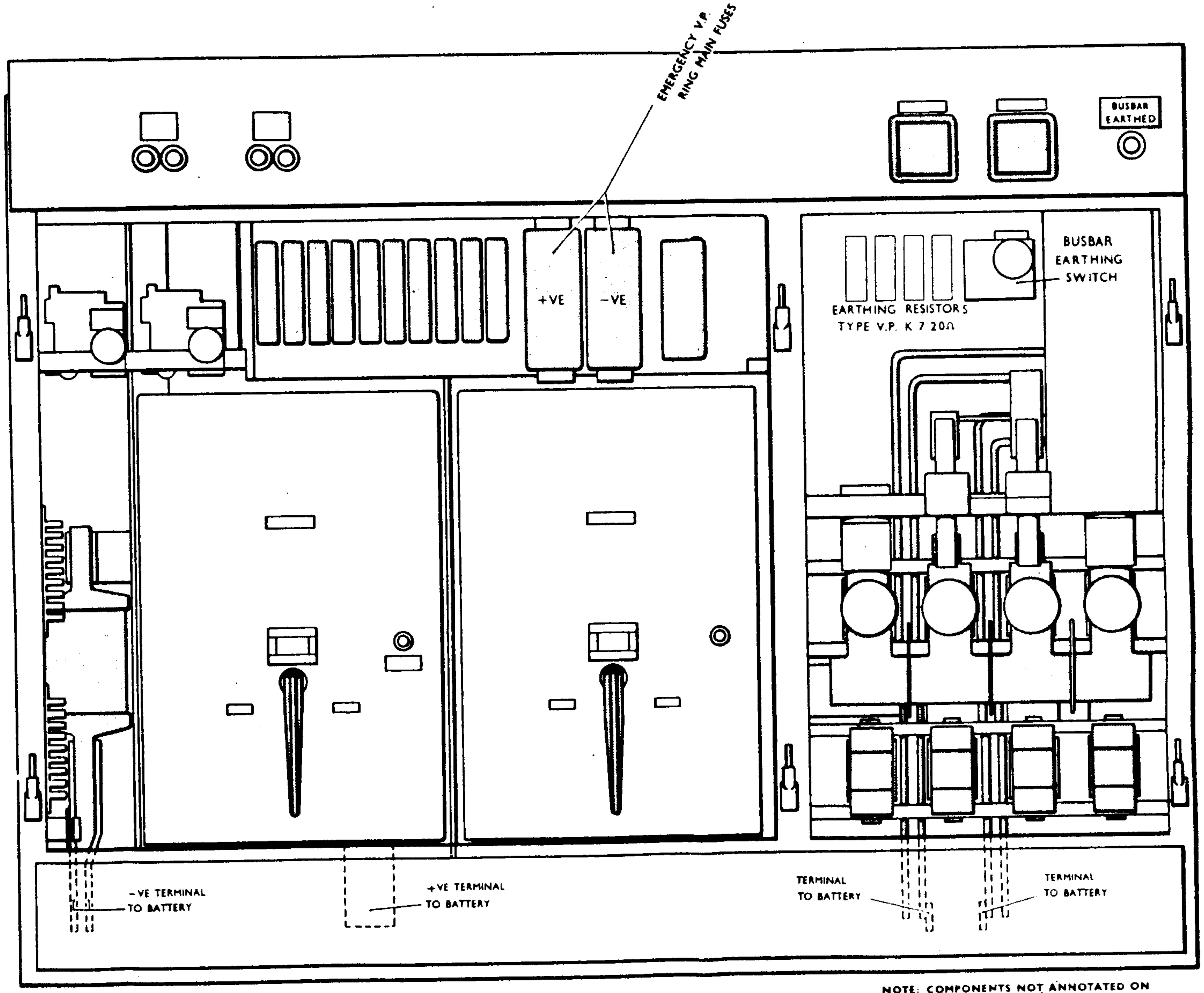
The four suppression circuits are mounted on a hinged panel, situated above the port camshaft motor. The fuses, and back-to-front ratio of each diode, should be occasionally checked. If the suppression circut becomes defective, any semi-conductor components connected directly to the bus-bars will be damaged (e.g. silicon diodes in conversions machinery VFR output circuits).



TRANSIENT VOLTAGE SUPPRESSION (Nº1 BATTERY)


EARTHING RESISTORS
TYPE V.P. K 7 20KΩ
BUSBARS EARTHED
MAIN
AUX
CIRCUIT BREAKER INDICATING LAMPS
BATTERY AMMETER SHUNT LEAD FUSES
BATTERY DISCHARGE METER FUSES
BATTERY VOLTMETER FUSES
MAIN POWER CIRCUIT BREAKER CONTROL SW. FUSES
AUX POWER CIRCUIT BREAKER CONTROL SW. FUSES
FUSES FOR C.P. RING MAIN VIA 'A' CONTACTOR
EMERGENCY SUPPLY FUSES FOR C.P. RING MAIN
FUSES FOR C.P. RING MAIN VIA 'B' CONTACTOR
SHORE CHARGING +VE A
SHORE CHARGING −VE A
MOTOR FIELD CENTRE POINT FUSE
MID POINT LINK SWITCH
SHORE CHARGING FUSES
CIRCUIT BREAKER CONTROL SWITCHES
MAIN
AUX.
+VE
−VE
+VE
−VE
+VE
−VE
BUSBAR EARTHING SWITCH
MAIN POWER CIRCUIT BREAKER
AUXILIARY POWER CIRCUIT BREAKER
BATTERY LAYING-OFF LINKS IN SOCKETS FOR SHORE CHARGING
BATTERY AMMETER SHUNT
OPEN
CLOSE
TRIP
N/V TRIP OVER RIDING PRESS BUTTON
OPEN
CLOSE
TRIP
N/V TRIP OVER RIDING PRESS BUTTON
SHORE CHARGING AMMETER SHUNTS BEHIND BATTERY LAYING-OFF LINKS
"NORMAL RUNNING" SOCKETS FOR BATTERY LAYING-OFF LINKS
−VE TERMINAL TO BATTERY
+VE TERMINAL TO BATTERY
TERMINAL TO BATTERY
TERMINAL TO BATTERY

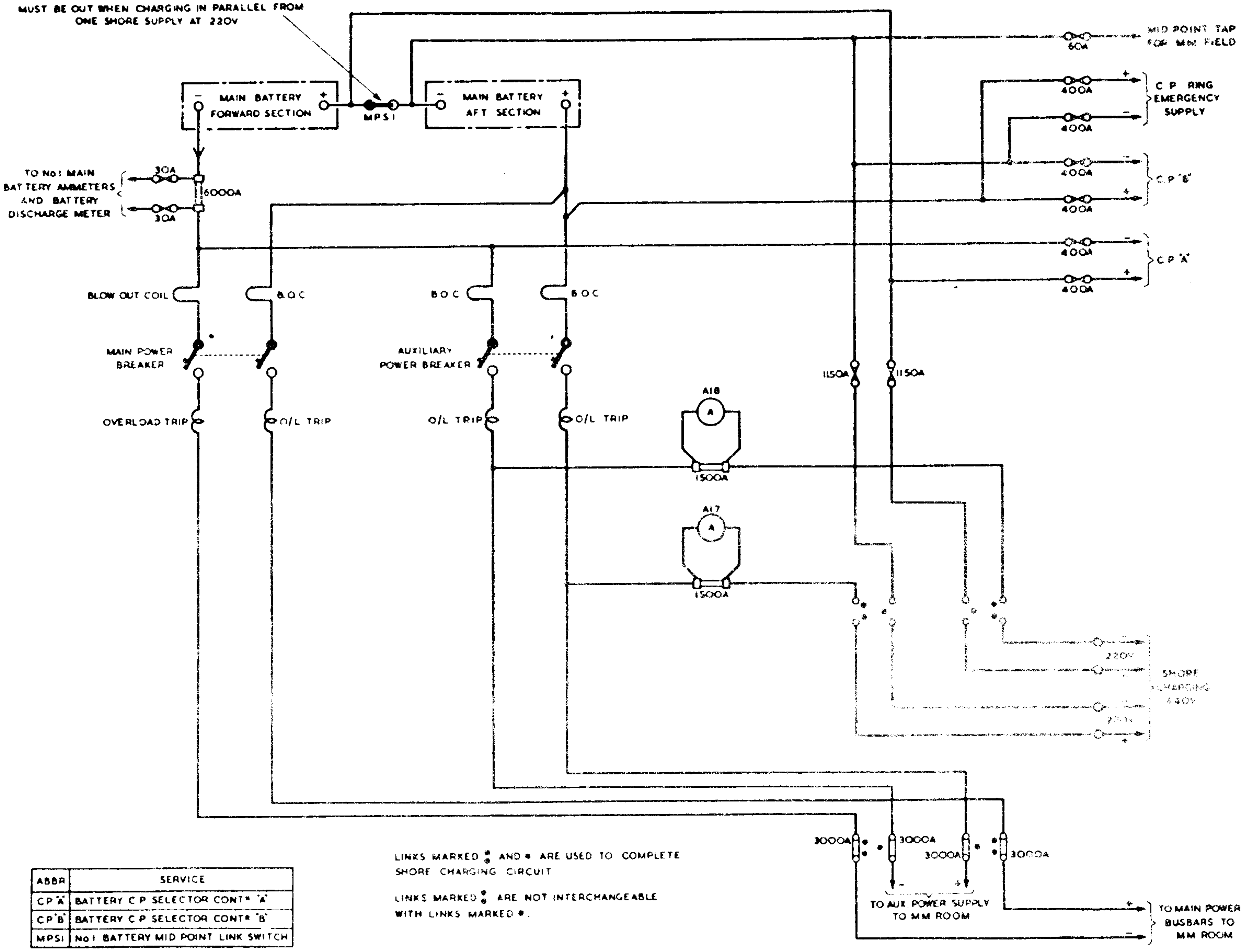
No. I SWITCHBOARD FRONT VIEW WITH HINGED DOORS REMOVED



No. 2 SWITCHBOARD FRONT VIEW WITH HINGED DOORS REMOVED

NOTE: COMPONENTS NOT ANNOTATED ON THIS SWITCHBOARD ARE SIMILAR TO THOSE ANNOTATED ON No. 1 SWITCHBOARD

No.1 BATTERY SWITCHBOARD POWER CIRCUITS – CIRCUIT DIAGRAM


MUST BE OUT WHEN CHARGING IN PARALLEL FROM ONE SHORE SUPPLY AT 220V
MAIN BATTERY FORWARD SECTION
MPS1
MAIN BATTERY AFT SECTION
TO No1 MAIN BATTERY AMMETERS AND BATTERY DISCHARGE METER
30A
30A
6000A
BLOW OUT COIL
B O C
B O C
B O C
MAIN POWER BREAKER
AUXILIARY POWER BREAKER
OVERLOAD TRIP
O/L TRIP
O/L TRIP
O/L TRIP
A18
A17
1500A
1500A
1150A
1150A
MID POINT TAP FOR MM FIELD
60A
C P RING EMERGENCY SUPPLY
400A
400A
C P 'B'
400A
400A
C P 'A'
400A
400A
220V
SHORE CHARGING 440V
220V
3000A
3000A
3000A
3000A
TO AUX POWER SUPPLY TO MM ROOM
TO MAIN POWER BUSBARS TO MM ROOM

LINKS MARKED ⁑ AND • ARE USED TO COMPLETE SHORE CHARGING CIRCUIT

LINKS MARKED ⁑ ARE NOT INTERCHANGEABLE WITH LINKS MARKED •.

ABBR	SERVICE
CP 'A'	BATTERY C P SELECTOR CONTR 'A'
CP 'B'	BATTERY C P SELECTOR CONTR 'B'
MPS1	No1 BATTERY MID POINT LINK SWITCH

Fig 2-8

No. 2 BATTERY SWITCHBOARD POWER CIRCUITS

CIRCUIT DIAGRAM

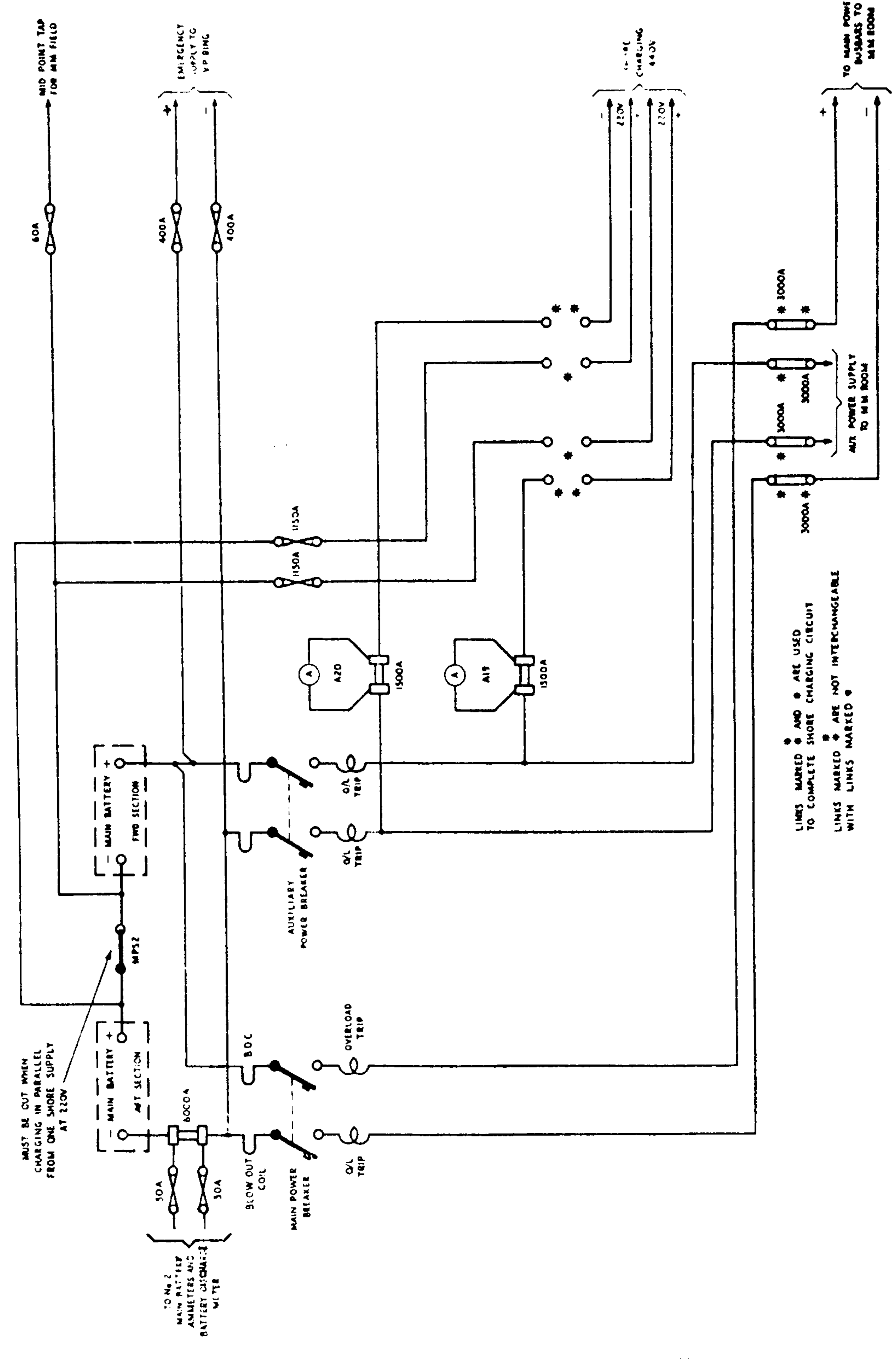
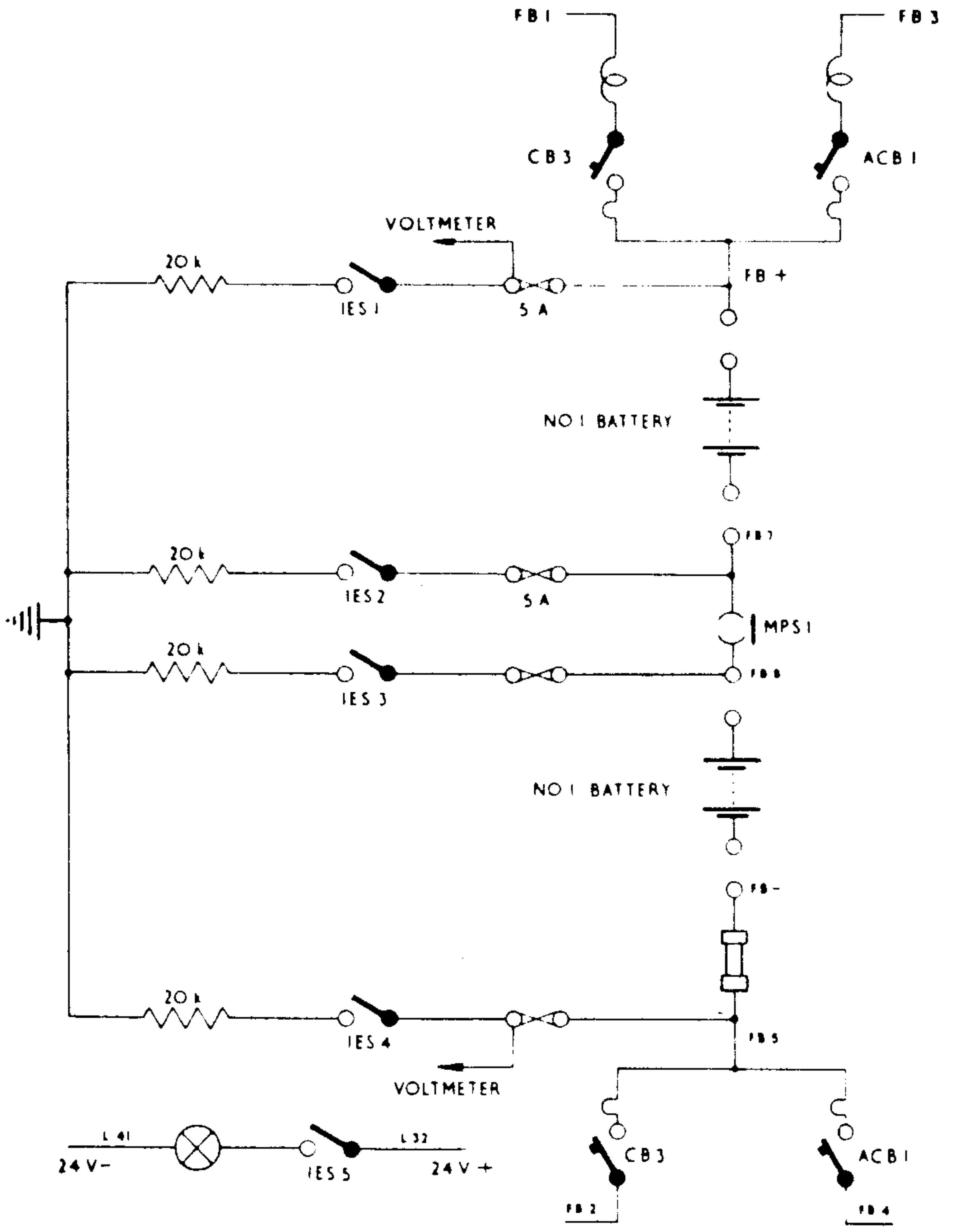

MID POINT TAP FOR MM FIELD
EMERGENCY SUPPLY TO VP RING
CHARGING 440V
220V
220V
TO MAIN POWER BUSBARS TO MM ROOM
60A
400A
400A
3000A
3000A
3000A
3000A
AUX POWER SUPPLY TO MM ROOM
1150A
1150A
A20
A19
1500A
1500A
MAIN BATTERY FWD SECTION
MPS2
MAIN BATTERY AFT SECTION
MUST BE CUT WHEN CHARGING IN PARALLEL FROM ONE SHORE SUPPLY AT 220V
6000A
30A
30A
TO No. 2 MAIN BATTERY AMMETERS AND BATTERY DISCHARGE METER
BOC
BLOW OUT COIL
MAIN POWER BREAKER
AUXILIARY POWER BREAKER
O/L TRIP
O/L TRIP
O/L TRIP
OVERLOAD TRIP
LINKS MARKED * AND * ARE USED TO COMPLETE SHORE CHARGING CIRCUIT
LINKS MARKED * ARE NOT INTERCHANGEABLE WITH LINKS MARKED *

Fig. 2-10

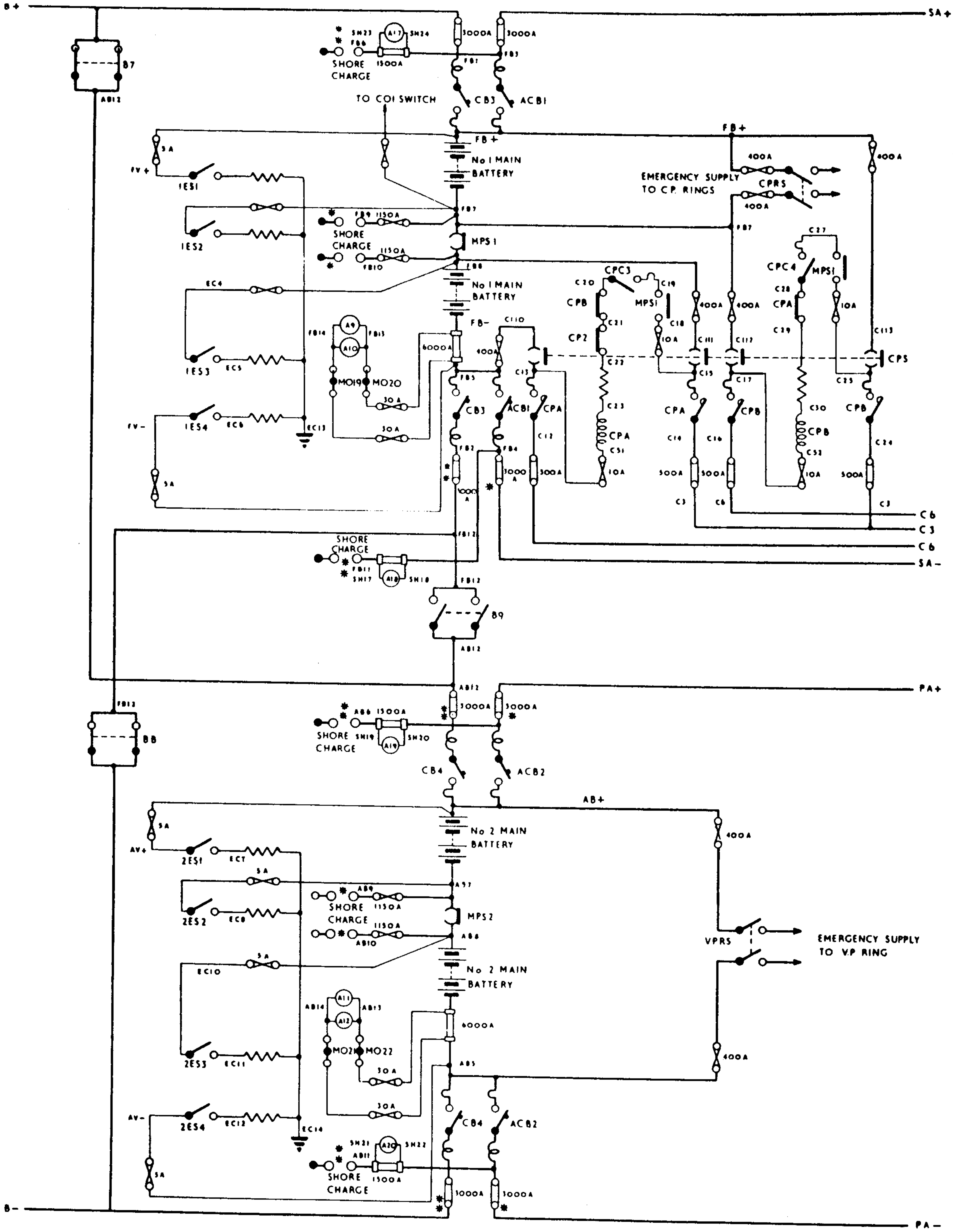


BATTERY BUSBAR EARTHING (No 1 SWITCHBOARD)

Fig 2-11

8. To enable work to be carried out on the batteries/battery switchboards a battery busbar earthing switch is fitted in each battery switchboard. The circuit for No.1 battery is shown above and the full procedure for the operation of this circuit is described in B.R. 1964(19A) PT1,CH2 page 31.

It basically involves laying off the battery by opening the main and auxiliary power breakers, opening the mid-point link switch, removing the battery laying-off links(* and ** links) and by also removing several sets of intercell connectors.(NOTE Refer to B.R. 1964(19A) for the Nos. of those intercell connectors to be removed



MAIN BATTERY CIRCUITS
Fig 2-14

Main Power Breaker Circuit Operation

A circuit for the close coil is completed through the local or remote set/trip switch, fine wire contacts, no-volt relay contact and MPLS contact.

If the bus-bars are dead, the NV relay contact will be open, the circuit can be completed through the position regulator cam contacts in the OFF position. The close coil operates CCI, its retaining circuit, and CC2. The latter provides a circuit for the set coil, which operates the breaker.

When the breaker operates CC1 and CC2 are opened mechanically, thus de-energising their respective coils, the breaker being held on the link and toggle mechanism under the influence of the no-volt trip coil.

The breaker is opened by operating the set/trip switch to trip, de-energising the no-volt trip coil which releases a toe to move the trip bar upwards which frees the link and toggle mechanism.

The main power breaker electrically inoperative if:

a. Control fuses blown or removed.

b. Fine wire switch is open.

c. MPLS open.

d. Bus-bars dead and main motor controller away from "STOP" position.

10.

	Circuit Breaker	Maker's Code	Purpose
a.	CB1 and CB2 main generator	NC2-F1 breakers	Fitted one in the output circuit of each main generator. Over-current trip at 4000 amps.
b.	M1 and M2 ACB1 and ACB2 main motor and auxiliary power breakers	NC2- G1	Fitted one in each of the power supplies to the main motors. One in each of the supplies to the auxiliary power circuits. Over-current trip at 6000 amps.
c.	CB3 and CB4 main power breakers	NC2-H1 breakers	Fitted on in the main output circuits of each main battery. Over-current trips at 13000 amps.

The basic circuit breaker is a two pole breaker which can be closed (set) mechanically by means of a handle on the front, or electrically by means of a solenoid. Either method operates a link and toggle mechanism, which closes the breaker main contacts. When the breaker is closed the solenoid becomes de-energised, and the breaker is held closed by a latch in the mechanical linkage. A trip bar running the length of the breaker is so arranged that a slight upward movement of the bar will trip the breaker. This pressure can be applied mechanically by the handle, or electro-magnetically by any one of the protective releases.

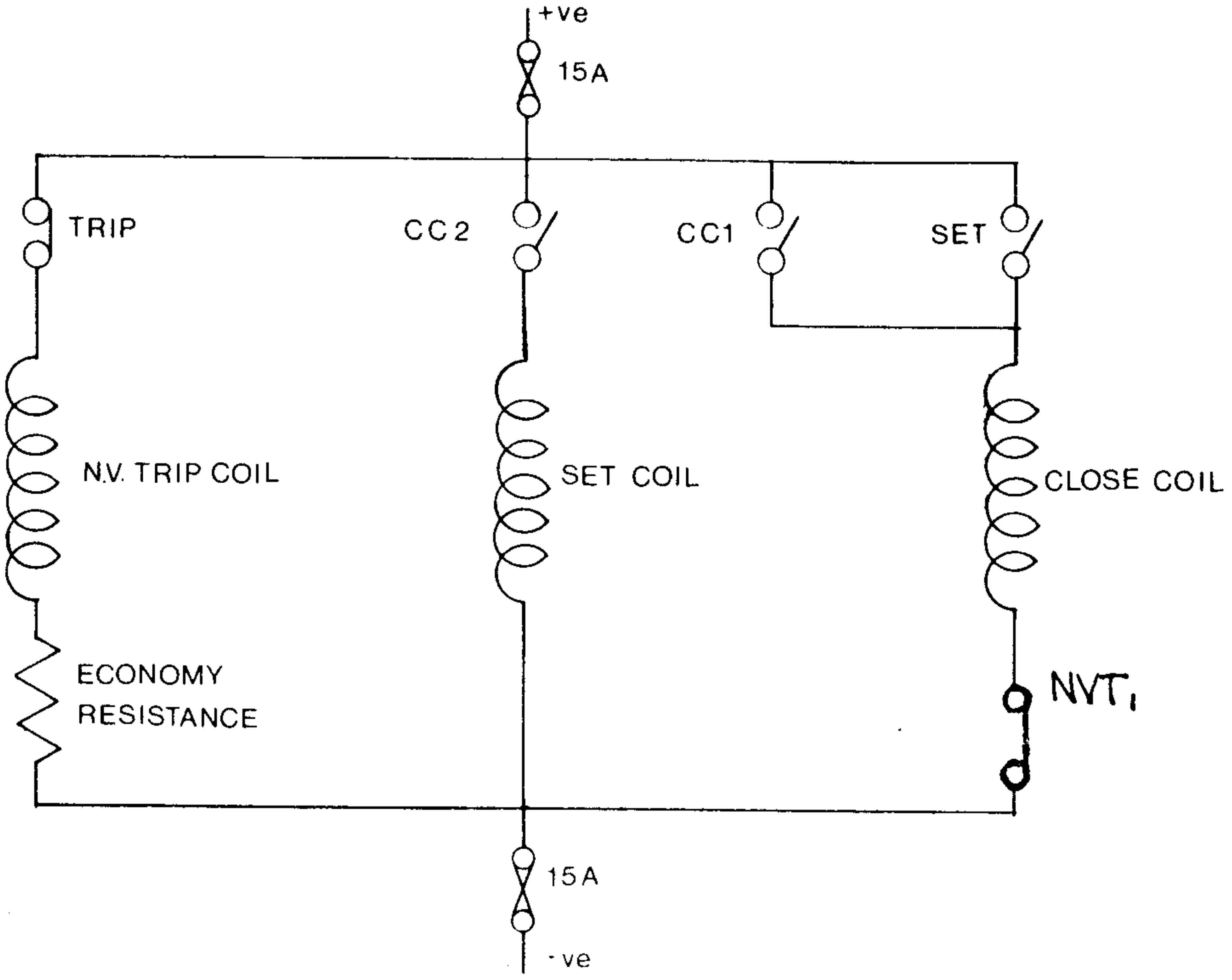
The protective releases are:

a. The over-current trip relay.

b. The no volt trip.

c. The reverse current trip (generator breakers only).

The over-current, reverse current and no volt trips apply pressure to the tripping lever to trip the breaker.



TYPICAL BREAKER CIRCUIT

Fig. 2-12

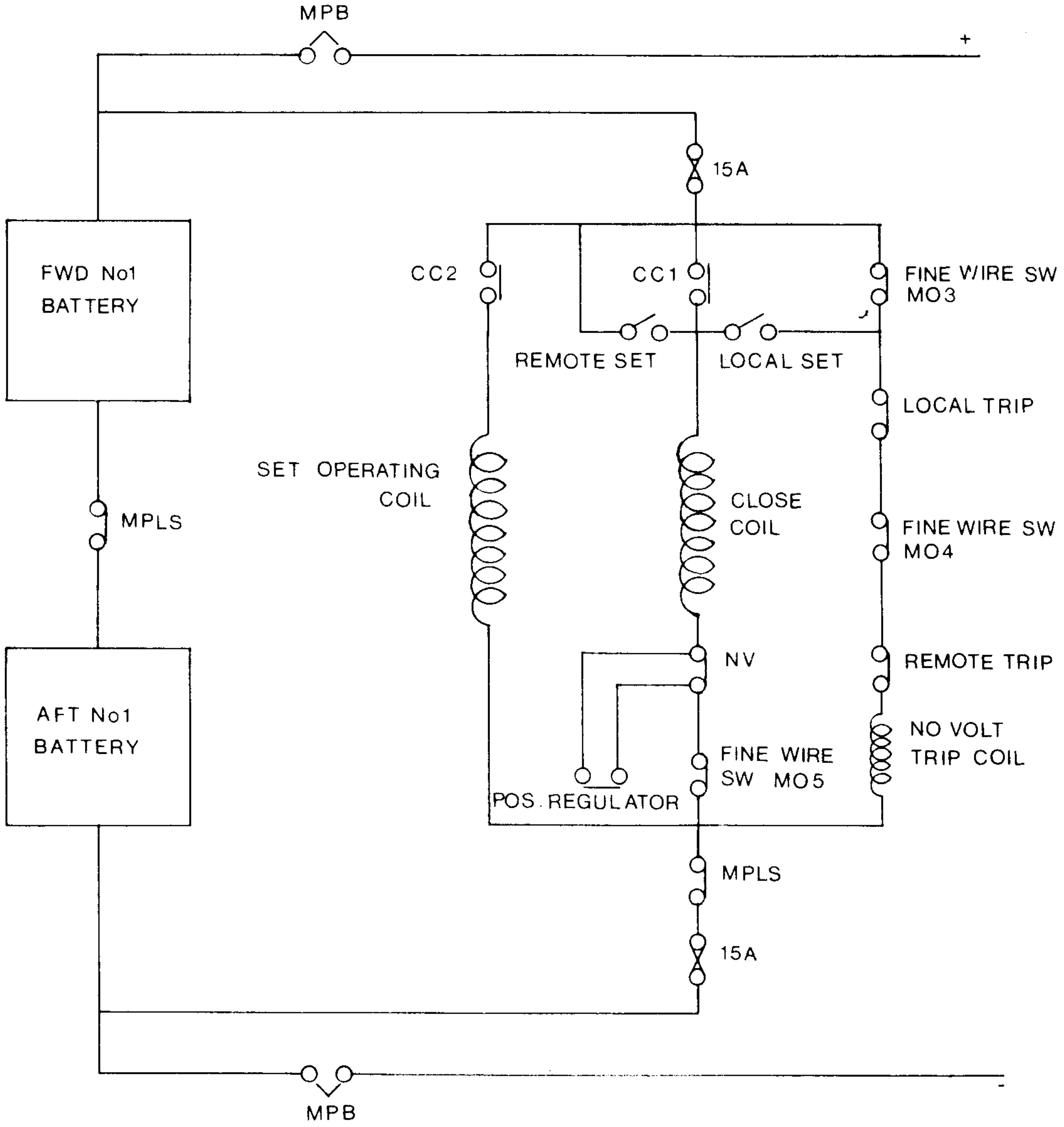
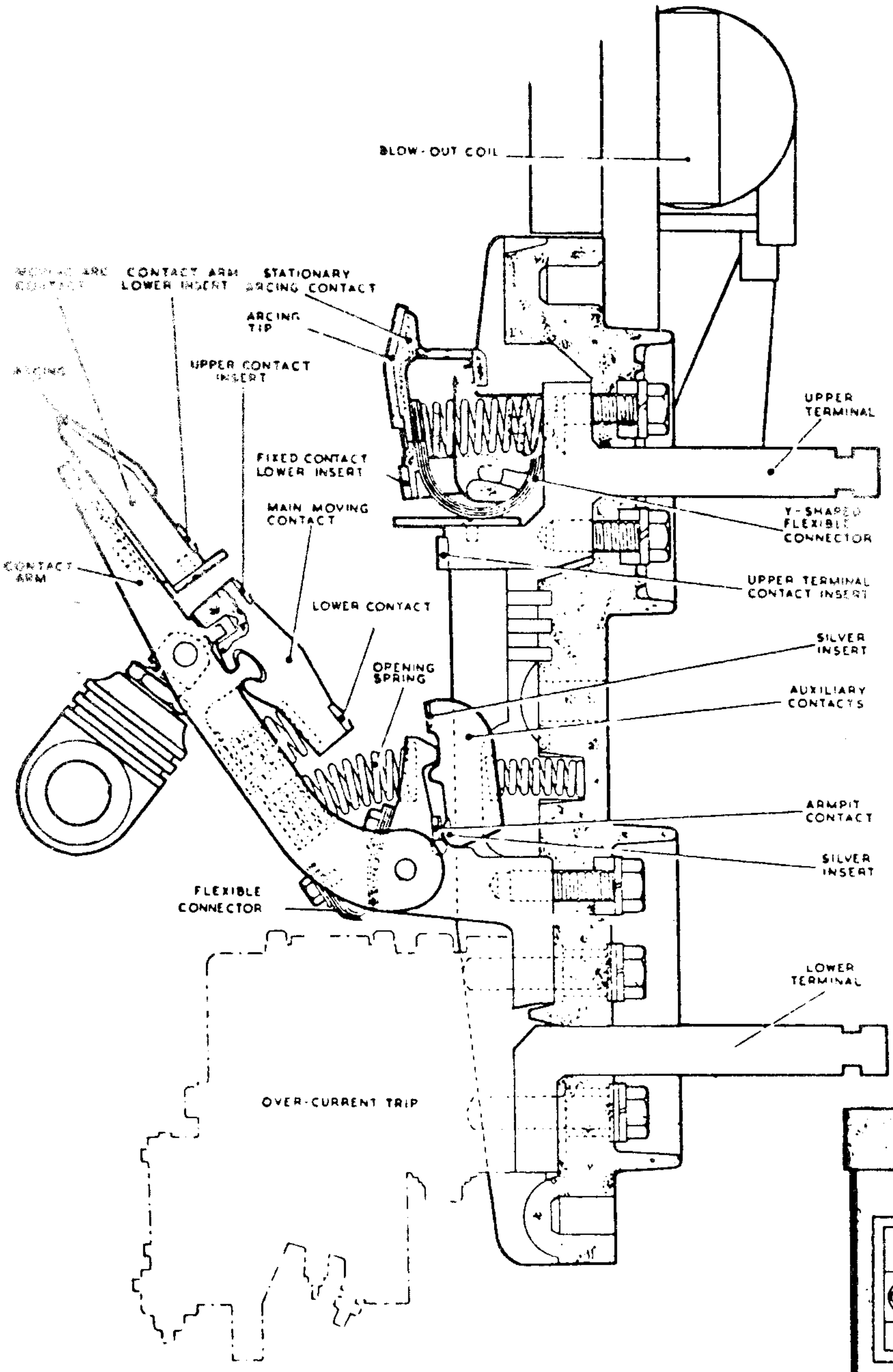


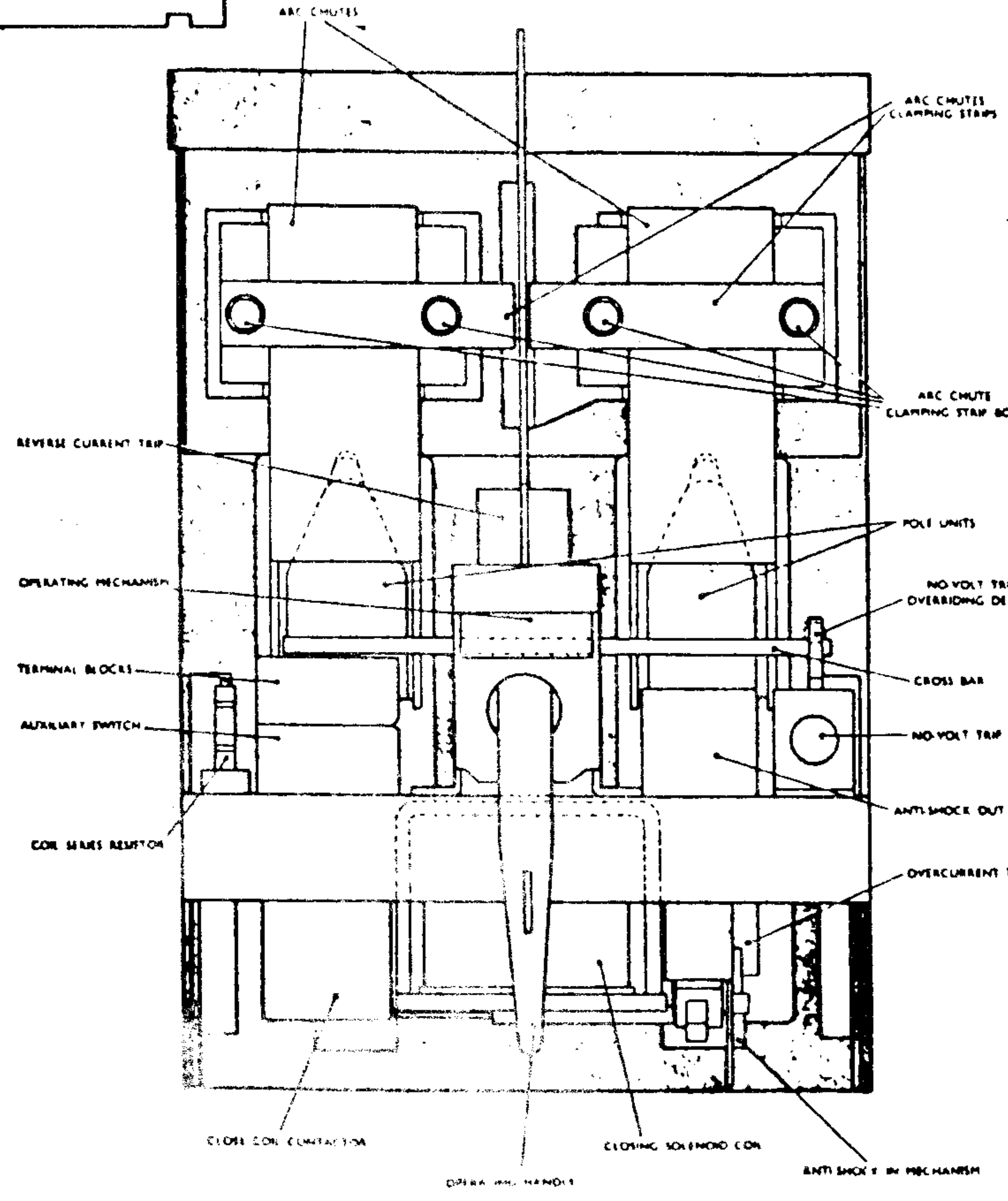
Fig. 2-13 **MAIN POWER BREAKER CIRCUIT**

CIRCUIT BREAKERS ARE ULTIMATE PROTECTION DEVICES; GREAT CARE MUST THEREFORE BE TAKEN TO ENSURE THAT ALL DESIGN SETTINGS ARE CORRECT AND THAT ALL PROTECTIVE DEVICES FUNCTION EFFICIENTLY.



POLE UNIT ASSEMBLY

Type	Service	Capacity
NC2-F1	Main Generators	4000A
NC2-G1	(i) Main Motor	6000A
	(ii) Auxiliary Power	
NC2-H1	Main Power (Battery)	13000A



LAYOUT OF CIRCUIT BREAKER

The power employed to energise the breaker solenoid (operating coil) involves a current too high for convenient control by remote switches; the solenoid circuit is therefore closed and opened by a "Close Coil Contactor". This contactor has two contacts, one for closing the breaker, the other for a "Close Coil Contactor" hold on circuit.

11. Overcurrent Trip Relay

This embodies most of the differences which distinguish the three types of breaker from each other.

12. No Volt Trip Relay

This comprises a coil with a series resistor, energised at the supply voltage. Its purpose is to prevent the circuit breaker from being closed, either by hand or power, when the circuit is dead, and to cause the breaker to open if the supply power fails.

The breakers are fitted with a no-volt release overiding device, which enables the breaker to be closed by hand and retained closed without the no-volt trip relay being energised. When a breaker has been closed under these conditions, it can only be tripped by hand at the breaker. But the over current and reverse current trips are still operative.

a. Minimum holding voltage 270 V DC.

b. Maximum drop off voltage 150 V DC.

13. Reverse Current Trip Relay

This relay is fitted only in the generator breakers and will operate at a reverse current of 200 to 250 amps.

The relay carries a heavy series coil which is connected in one pole and a heavy magnet. The two magnetic fields are centred on one armature and if the current in the series coil is reversed, the armature is caused to move and strike the breaker trip bar, causing the breaker to open.

14. Circuit Breaker Pole Units

Assume that the current enters at the lower terminal; it passes from the arm pit contact of the hinge block to four auxiliary contacts, which have silver inserts. In the closed position the upper contact inserts of the auxiliary contacts make with the lower contact inserts of the main moving contacts.

There are two main moving contacts in each pole unit, so that each one engages with two auxiliary contacts. The upper contact inserts of the main moving contacts make with the upper terminal contact.

When the contact arm is opened, the main moving contacts and the auxiliary contacts break before the arcing tips. An arc then forms from the arcing tips in the shape of a loop and the magnetic field produced by this loop forces the arc into the arc chute and due to the action of the blow out coil, the arc is forced further into the chute, where it is split up by a barrier system.

15. Protective Devices Fitted to Breakers

a. No volt release.

b. Over-current release.

c. Anti-shock "IN" and anti-shock "OUT" devices.

d. Reverse current release (only fitted to Generator Breakers).

16. Fine Wire Isolating Switch

The purpose of the fine wire isolating switch is to isolate the motor room switchboard.

The switch is situated in the motor room passage opposite the cubicle. When open, it links the main and auxiliary power breakers. It opens the following circuits:

MO1 - Star, mid point tapping
MO2 - Not used
MO3 - No. 1 main power breaker control circuit
MO4 - No. 1 main power breaker control
MO5 - Main power breaker control
MO6 - No. 2 main breaker control
MO7 - No. 2 main breaker control
MO8 - Main power breaker control
MO9 - No. 1 auxiliary braeker control
MO10 - Auxiliary breaker control
MO11 - Auxiliary breaker control
MO12 - No. 2 auxiliary breaker control
MO13 - Auxiliary breaker control
MO14 - Auxiliary breaker control
MO15 - No. 1 battery voltmeter
MO16 - No. 1 battery voltmeter
MO17 - No. 2 battery voltmeter
MO18 - No. 2 battery voltmeter
MO19 - No. 1 battery ammeter
MO20 - No. 1 battery ammeter
MO21 - No. 2 battery ammeter
MO22 - No. 2 battery ammeter

17. SPARE

18. SPARE

19. SPARE

20. Main Generators

The purpose of the main generators is to supply current for charging the batteries, or for running electric motors.

The generator outputs are connected to the main porpulsion bus-bars by breakers (CB1 and CB2) fitted with over-current and reverse current releases also no-volt released. The breakers are operated electrically from the main power switchboard or by hand at the breaker.

Cooling is achieved by means of an impeller mounted on the commutator end of the shaft, which circulates the air through a filter and a water cooled air cooler. A gauze covered opening below the terminal box allows make up air to enter the machine.

21. Main Generators - Charging

After the usual preliminaries have been carried out, the diesel engines are run up, and when ready for load the motor room is informed. The motor room watchkeeper then puts the voltmeter selector switch to the oncoming generator and adjusts the generated voltage to 5 volts above the bus-bar volts, by means of the generator shunt field regulator on the auxiliary power switchboard. He then sets the generator breaker by means of a set-trip switch on the main power switchboard. The generator is loaded to about 1000 amps, then the supercharger is put in to allow maximum power to be generated.

To put the other generator on load in parallel, the voltmeter selector switch is changed to the oncoming generator and the same procedure is carried out.

To break the charge, the motor room watchkeeper reduces the generator OP to approximately 100 amps and trips the breaker. The MTP will then stop the diesel engine.

The generator reverse current release will operate at 200-250 amps reverse current.

22. Main Generator Temperatures

The temperature should not be allowed to rise more than 63° F above sea water cooling temperature (maximum allowable temperature is 150°F)

23. Main Generator Field Current

The field current must not exceed 7.8 amps. (9A - OTAMA and ORION).

24. Main Generator Build-Up

a. The Shunt Field is former wound, insulated with mica and asbestos tape. The machine is self excited and each coil is separately connected in the terminal box, so that a faulty field can be isolated.

b. The Armature is mounted on a fluted forged steel shaft, designed to withstand shock loading. The core is built of insulated laminations with radial air ducts.

c. The Commutator is 28½ inches in diameter, made up of high conductivity silver bearing copper bars, insulated by milanite separators undercut to one tenth of an inch.

d. The Brush Gear consists of box type tensator spring adjusting for brush wear. They are bolted to the brush arms which are bolted and insulated from the rocker rings. The rocker ring is mounted in ball bearing, and clamped to the end bracket with bolts for the fan volute. A dowel locates the rocker ring in position which is marked by an indicator. The ring can be rotated without removing the end shield. Eight brushes are fitted to each of the six brush arms.

e. Three 240 Watt Heaters are mounted in the lower half of the commutator end shield. A removable cover provides access.

f. Armature Weight - 3 tons.

25. Putting on a Charge

a. Take battery readings, enter in log and on battery state board.

b. Start battery agitation system.

c. Check battery cooling system running if temperature is above 95° F or likely to exceed 95° F.

d. Sight battery sumps.

e. Switch off H2 fans and shut H2 master inlets and outlets.

f. Open up battery ventilation outboard in harbour, inboard at sea.

g. Start battery fans.

h. Check battery ventilation running correctly.

i. Switch off generator heaters.

j. Check that grouper is NOT at batteries in series.

k. Check main power breakers set.

l. Check that there are no main power earths.

m. Inform duty officer.

n. ERA starts engine and adjusts revs. (850 RPM)

o. Put voltmeter selector switch to oncoming generator.

p. Adjust generator volts to approximately 5 volts above battery volts.

q. Make generator circuit breaker.

The generator is first loaded to approximately 1000 amps, then superchargers are put in, and adjusted to the required charging rate.

26. Breaking a Charge

a. Inform the engine room.

b. Reduce load.

c. Trip generator breaker when current is just below 200 amps.

d. ERA shuts down diesel engine.

27. Generator Breaker Trips

The main generator breaker is electrically inoperative if:

a. The control fuses are blown or removed.

b. The grouper switch is to "batteries-in-series".

c. The voltmeter selector switch is not to the oncoming generator.

d. The bus-bars are dead

28. Charging Whilst Snorting

The following precautions are to be taken:

a. An operational charge may be completed. Exceptionally, an equalising or normal charge may be carried out when specifically allowed by exercise or trial orders.

b. Engine revolutions must not fall below 850 rpm, and whenever possible two engines should be running.

c. Battery ventilation fans must be running.

d. All ship's ventilation fans (supply and exhaust) are to be running at full speed.

e. No smoking is to be enforced after the voltage initially reaches 538 V (i.e. at the first reduction).

f. On stopping snorting the battery ventilation is to be left running until told to "secure from snorting".

g. Any main power earths.

30. Running Charge

The battery is only to be floated when:

a. The order "MAXIMUM REVOLUTIONS TO FLOAT THE LOAD" is given.

b. "FLOAT THE LOAD" is specifically ordered.

c. When the maximum charging rate available is less than 280 amps each battery.

At all other times, the maximum allowable available charging rate is to be used.

The battery is never to be gassed without the permission of the OOW.

31. Electrical Reasons for Breaking a Charge

a. Any evolution

b. Grouping to batteries-in-series.

c. Field curret exceeds 7.8A(9A Orion & Otama)

d. Two or more battery fan running lights going out.

e. Battery temperature rising above 125° F.

f. Generator air temperature more than 63° above sea water.

g. Loss of communications with the powerhouse

h. If in any doubt for any reason.

32. Charging the Batteries of Another "O" Class Submarine

A facility exists to charge the batteries of another "O" class submarine. Detailed instructions are contained in BR 1964 (19A).

Main Motors

The main motors consist of two armatures, mounted back to back on a common shaft. They are enclosed in a casing which is watertight to shaft level and splashproof above.

Mechanical pumps driven from the shaft and situated at the forward and after end of the main motors, draw oil from a 12 gallon sump and force it through the bearings.

The machines are forced air and water cooled, and an anti-condensation heater is fitted inside the lower casing, this is to be switched on when the main motor is not in use.

The main motor commutators are to be sighted at least once per watch whilst at sea.

33. Bearing Temperatures

Main motor bearing thermometers are to be checked frequently at the auxiliary control panel. If there is any individual rise in temperature or if the temperature exceeds 130° the ERA of the watch is to be informed.

34. Cooling Air Temperatures

The maximum outlet air temperature is 164°F

The maximum difference between inlet and outlet temperatures is 54°.

Any temperatures in excess of these limits is to be reported to the OOW immediately. All temperatures are in degrees F.

35. Maximum Main Motor Load

The maximum continuous rating for main motors is 1250 amps per armature group up.

36. Main Motor Details

a. The Main Field Windings. These consist of shunt and series coils. The shunt coils are former wound, series are copper strip insulated with asbestos and mica tape.

b. The Shunt Coils. Separately connected in a shunt terminal box so that a faulty coil may be isolated.

The commutator poles are made from copper strip wound on edge mica and asbestos tape insulated.

c. The Armature Coils. Mounted on a fluted forged steel shaft, designed to withstand shock loading. They are built up of insulated laminations and are provided with radial air ducts for armature cooling. The armature coils are former wound and pressed into the armature slots and wedged by resin treated asbestos board.

d. The Commutator. Each commutator is 32 inches in diameter, built up of high conductivity silver bearing copper bars, insulated by micanite separators undercut to 1/32 inch.

e. Brush Holders. These are box type adjustable for commutator wear. Bolted to the brush arms which are insulated from the roller rings. There are six brush arms, five brushes on each arm.

f. The Rocker Ring. Mounted in ball bearings and clamped into position and located by a dowel pin.

Eight in number 240 watt strip heaters are provided in each tandem set. Four are mounted in the centre of the machine between the field systems and two at each end of the lower half of the end shields.

Armature	- 9 tons 1 cwt.
Complete Motor	- 29 tons.

37. Motor Room Bilge Alarm

Main motors are watertight up to shaft level, and splash tight above. An alarm system is fitted to indicate by bell and warning light when liquid in the lower motor room bilge is at a dangerous level. This is done by means of a switch, fitted on a ball float which rises with the liquid in the bilge. A test switch is fitted on this system.

38. Main Motor Circuit Breakers

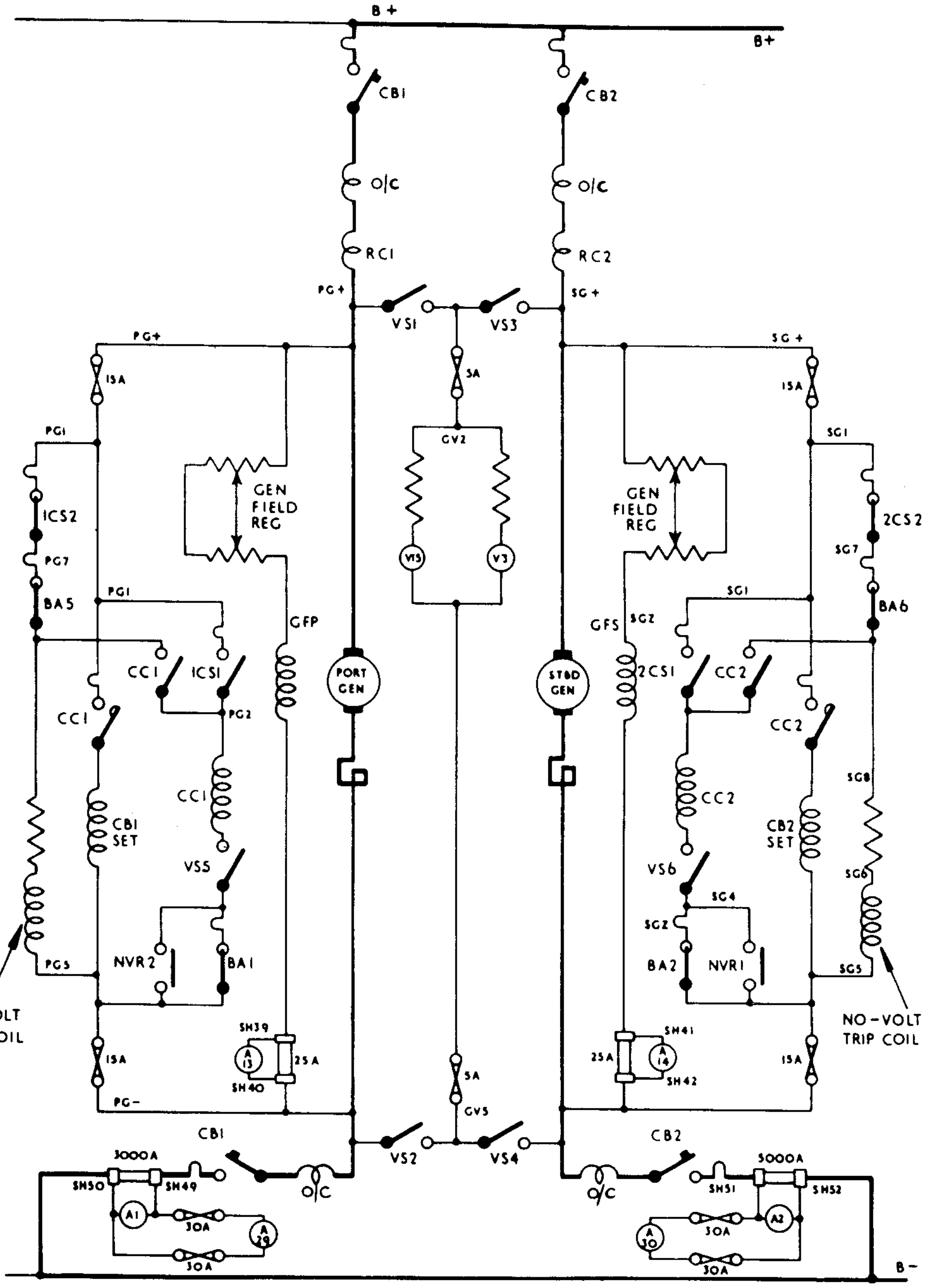
A double pole circuit breaker is provided for each of the main motors. They are fitted with overcurrent and no-volt release, also anti-shock "in" and "out" devices.

Their purpose is to connect the main motors to the main propulsion bus-bars. They are situated at the for'd end of the port and starboard main frames.

They are controlled as follows:

a. Remotely by set/trip switch at the main porpulsion switchboard.

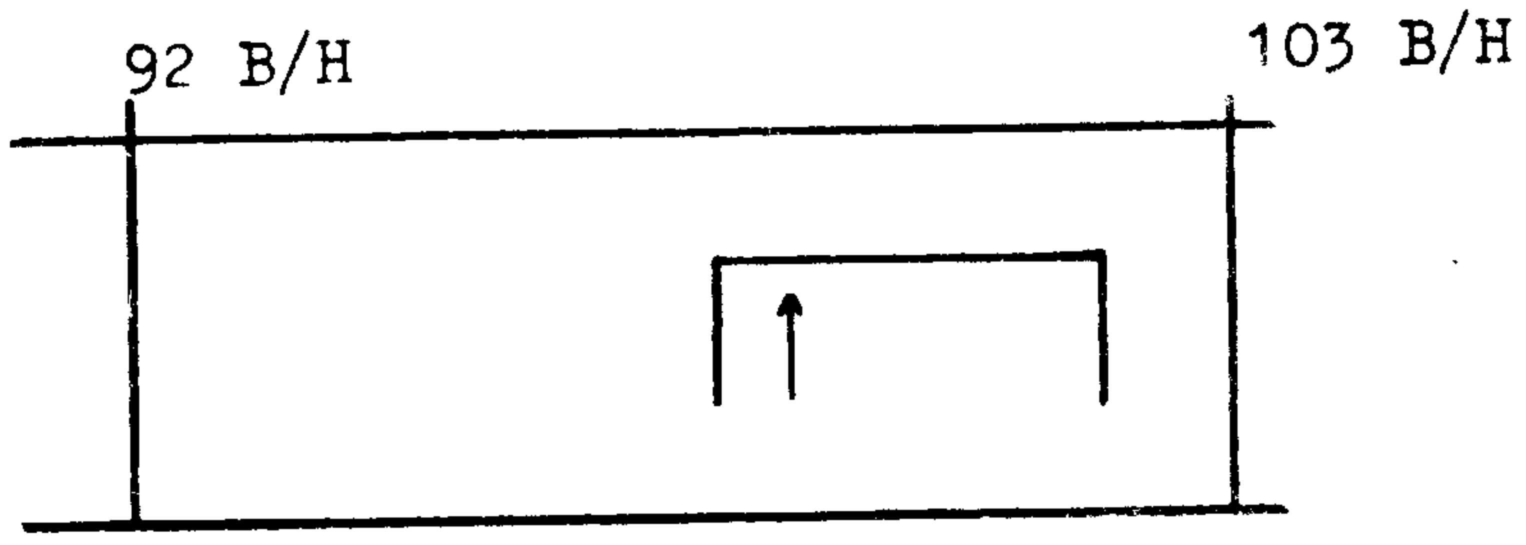
b. By hand at the breaker itself.

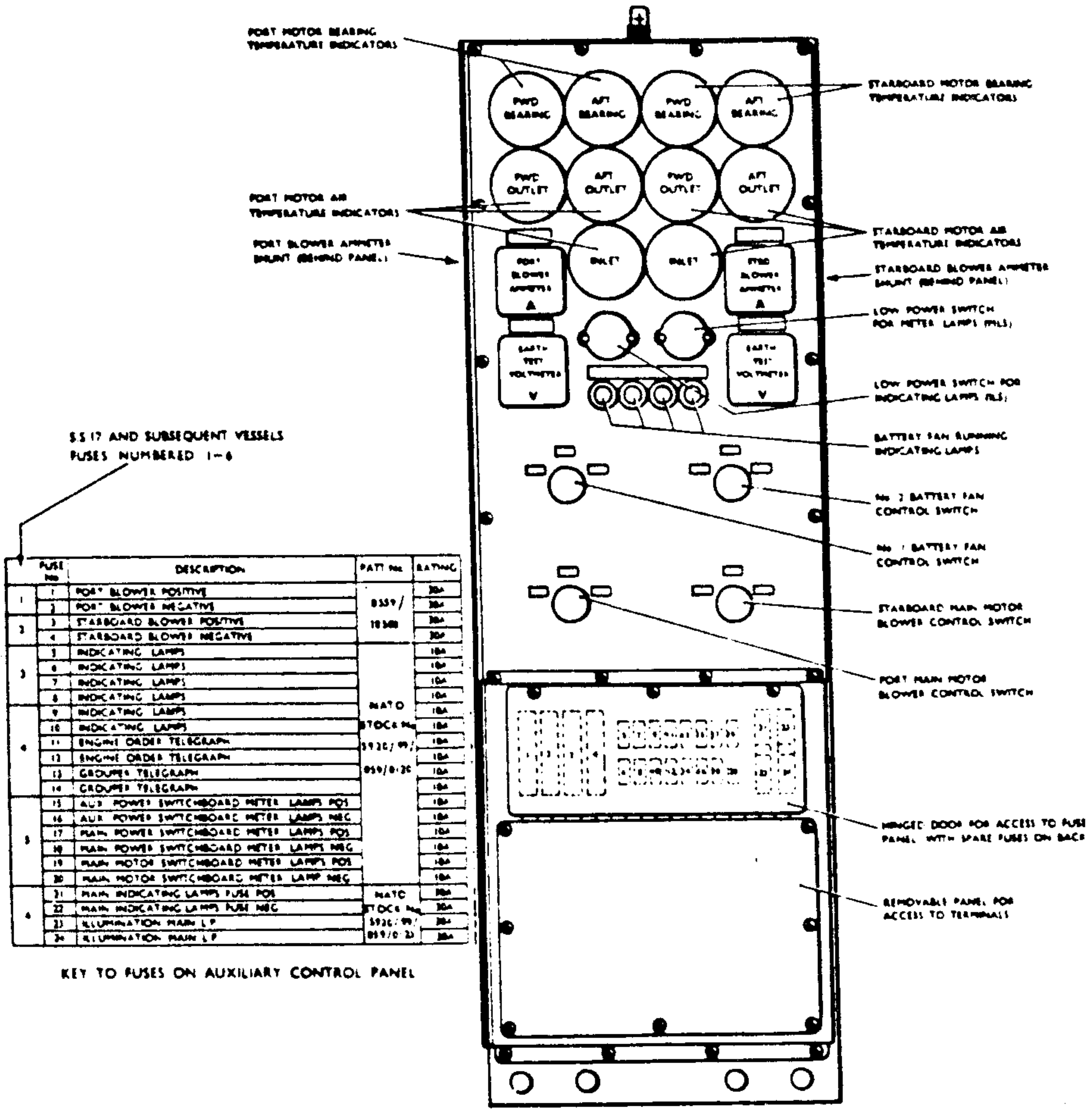


MAIN GENERATOR AND CIRCUIT BREAKER CIRCUITS

Fig. 2-17

Auxiliary Control Panel




PORT MOTOR BEARING TEMPERATURE INDICATORS
PORT MOTOR AIR TEMPERATURE INDICATORS
PORT BLOWER AMMETER SHUNT (BEHIND PANEL)
FWD BEARING
AFT BEARING
FWD OUTLET
AFT OUTLET
INLET
PORT BLOWER AMMETER
STBD BLOWER AMMETER
EARTH TEST VOLTMETER
STARBOARD MOTOR BEARING TEMPERATURE INDICATORS
STARBOARD MOTOR AIR TEMPERATURE INDICATORS
STARBOARD BLOWER AMMETER SHUNT (BEHIND PANEL)
LOW POWER SWITCH FOR METER LAMPS (MLS)
LOW POWER SWITCH FOR INDICATING LAMPS (ILS)
BATTERY FAN RUNNING INDICATING LAMPS
No 2 BATTERY FAN CONTROL SWITCH
No 1 BATTERY FAN CONTROL SWITCH
STARBOARD MAIN MOTOR BLOWER CONTROL SWITCH
PORT MAIN MOTOR BLOWER CONTROL SWITCH
HINGED DOOR FOR ACCESS TO FUSE PANEL WITH SPARE FUSES ON BACK
REMOVABLE PANEL FOR ACCESS TO TERMINALS
S.S 17 AND SUBSEQUENT VESSELS FUSES NUMBERED 1–6

	FUSE No	DESCRIPTION	PATT No	RATING
1	1	PORT BLOWER POSITIVE	0359/ 10500	30A
	2	PORT BLOWER NEGATIVE		30A
2	3	STARBOARD BLOWER POSITIVE		30A
	4	STARBOARD BLOWER NEGATIVE		30A
3	5	INDICATING LAMPS	NATO STOCK No 5920/99/ 059/0120	10A
	6	INDICATING LAMPS		10A
	7	INDICATING LAMPS		10A
	8	INDICATING LAMPS		10A
4	9	INDICATING LAMPS		10A
	10	INDICATING LAMPS		10A
	11	ENGINE ORDER TELEGRAPH		10A
	12	ENGINE ORDER TELEGRAPH		10A
	13	GROUPER TELEGRAPH		10A
	14	GROUPER TELEGRAPH		10A
5	15	AUX POWER SWITCHBOARD METER LAMPS POS		10A
	16	AUX POWER SWITCHBOARD METER LAMPS NEG		10A
	17	MAIN POWER SWITCHBOARD METER LAMPS POS		10A
	18	MAIN POWER SWITCHBOARD METER LAMPS NEG		10A
	19	MAIN MOTOR SWITCHBOARD METER LAMPS POS		10A
	20	MAIN MOTOR SWITCHBOARD METER LAMP NEG		10A
6	21	MAIN INDICATING LAMPS FUSE POS	NATO STOCK No 5920/99/ 059/0[illegible]	30A
	22	MAIN INDICATING LAMPS FUSE NEG		30A
	23	ILLUMINATION MAIN L.P		30A
	24	ILLUMINATION MAIN L.P		30A

KEY TO FUSES ON AUXILIARY CONTROL PANEL

Principal controls and indications

1. Battery ventilation fans control switches and running indication.
2. Port & stbd. main motor blower switches and indication.
3. Positive and negative main power earth voltmeters.
4. Port & stbd. main motor air and bearing temperature gauges.
5. Switches for indicating lights on the main propulsion switchboard, auxiliary control panel, main power switch board and the auxiliary power switchboard.

The main motor breaker is electrically inoperative if:

a. Both main power breakers are not set.

b. The 60 amp control fuses are blown or removed.

c. The starter camshaft is away from the STOP position.

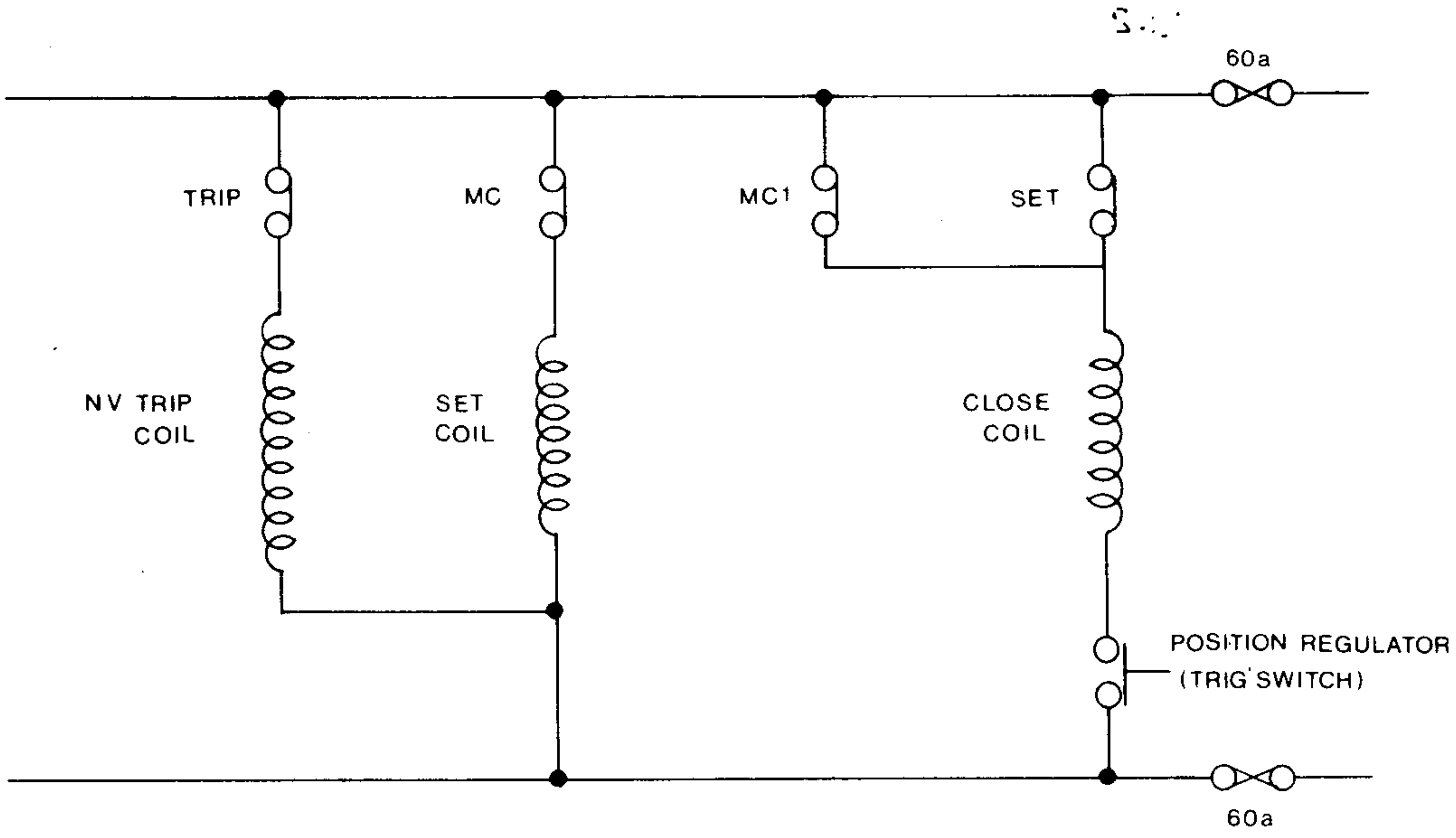
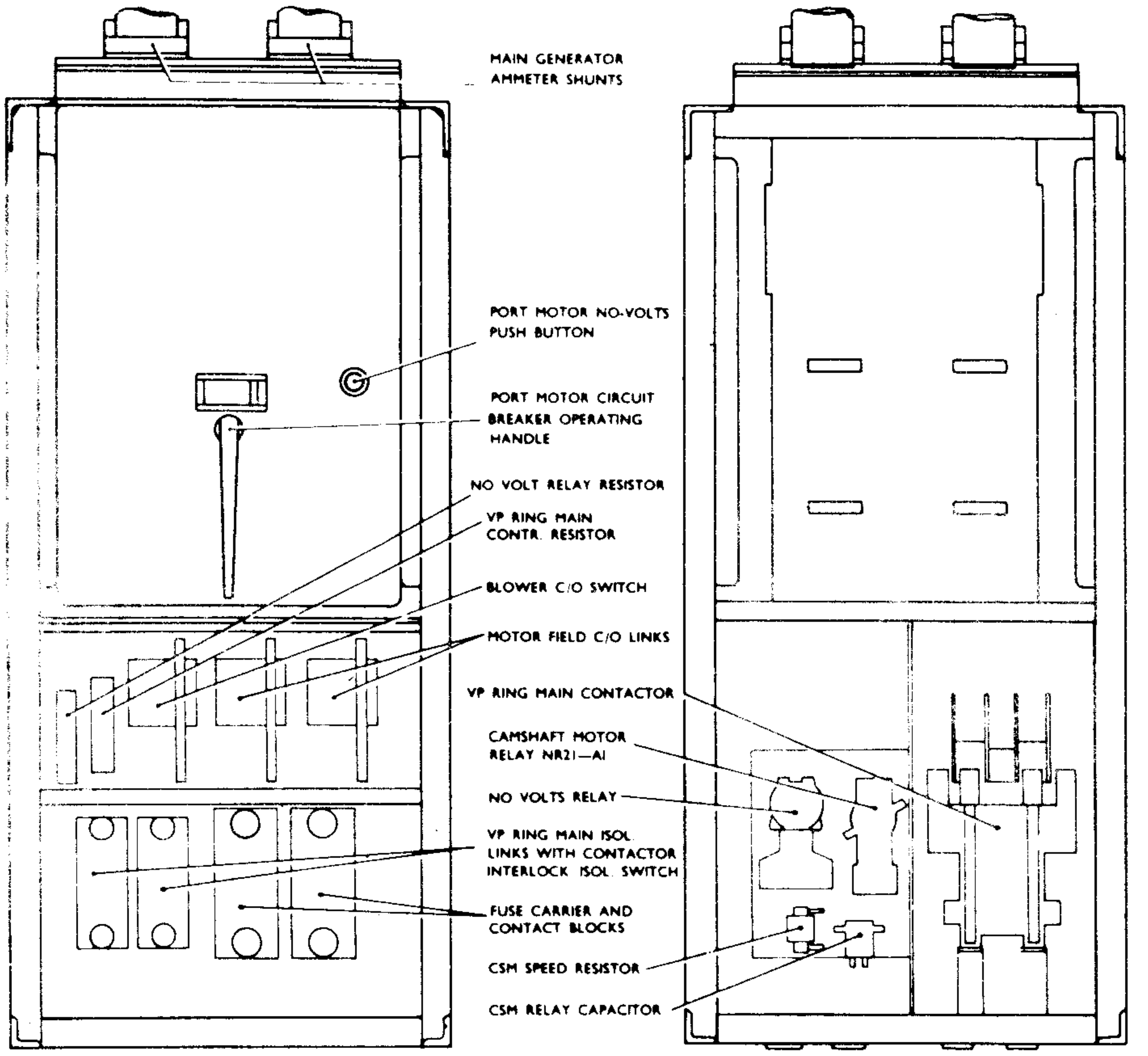
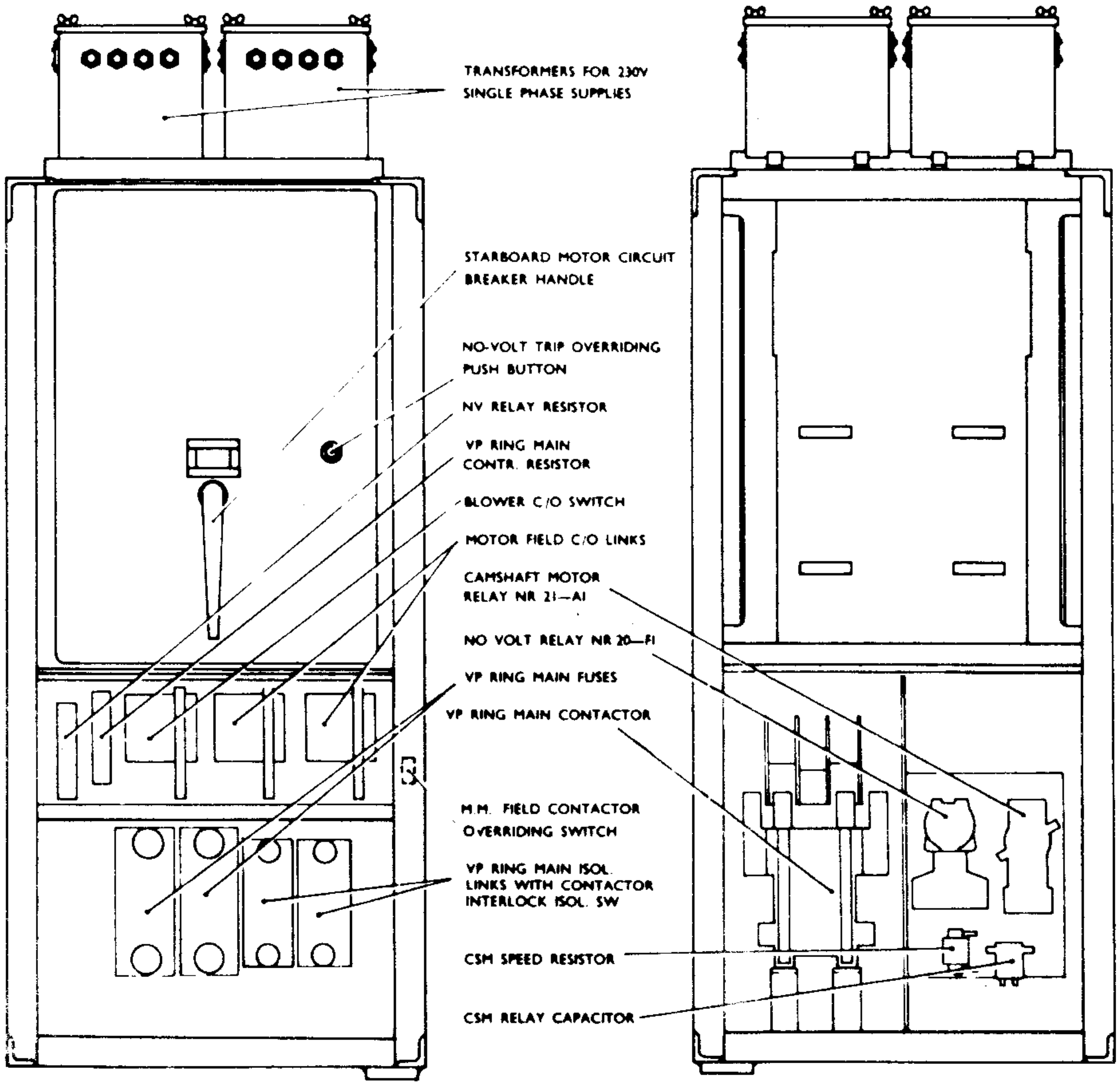


Fig. 2-19 **MAIN MOTOR BREAKER CIRCUIT**


MAIN GENERATOR AMMETER SHUNTS
PORT MOTOR NO-VOLTS PUSH BUTTON
PORT MOTOR CIRCUIT BREAKER OPERATING HANDLE
NO VOLT RELAY RESISTOR
VP RING MAIN CONTR. RESISTOR
BLOWER C/O SWITCH
MOTOR FIELD C/O LINKS
VP RING MAIN CONTACTOR
CAMSHAFT MOTOR RELAY NR21—AI
NO VOLTS RELAY
VP RING MAIN ISOL. LINKS WITH CONTACTOR INTERLOCK ISOL. SWITCH
FUSE CARRIER AND CONTACT BLOCKS
CSM SPEED RESISTOR
CSM RELAY CAPACITOR

PORT FRAME—FRONT VIEW

PORT FRAME—REAR VIEW


TRANSFORMERS FOR 230V SINGLE PHASE SUPPLIES
STARBOARD MOTOR CIRCUIT BREAKER HANDLE
NO-VOLT TRIP OVERRIDING PUSH BUTTON
NV RELAY RESISTOR
VP RING MAIN CONTR. RESISTOR
BLOWER C/O SWITCH
MOTOR FIELD C/O LINKS
CAMSHAFT MOTOR RELAY NR 21—AI
NO VOLT RELAY NR 20—FI
VP RING MAIN FUSES
VP RING MAIN CONTACTOR
M.M. FIELD CONTACTOR OVERRIDING SWITCH
VP RING MAIN ISOL. LINKS WITH CONTACTOR INTERLOCK ISOL. SW
CSM SPEED RESISTOR
CSM RELAY CAPACITOR

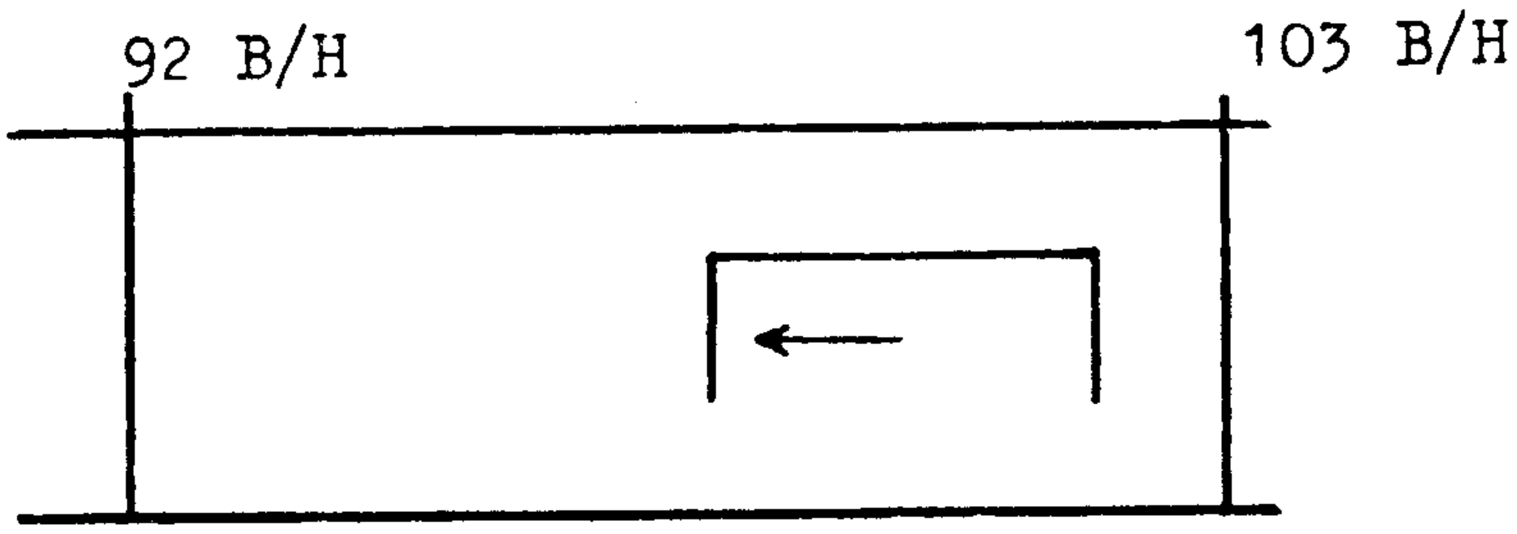
STARBOARD FRAME—FRONT VIEW

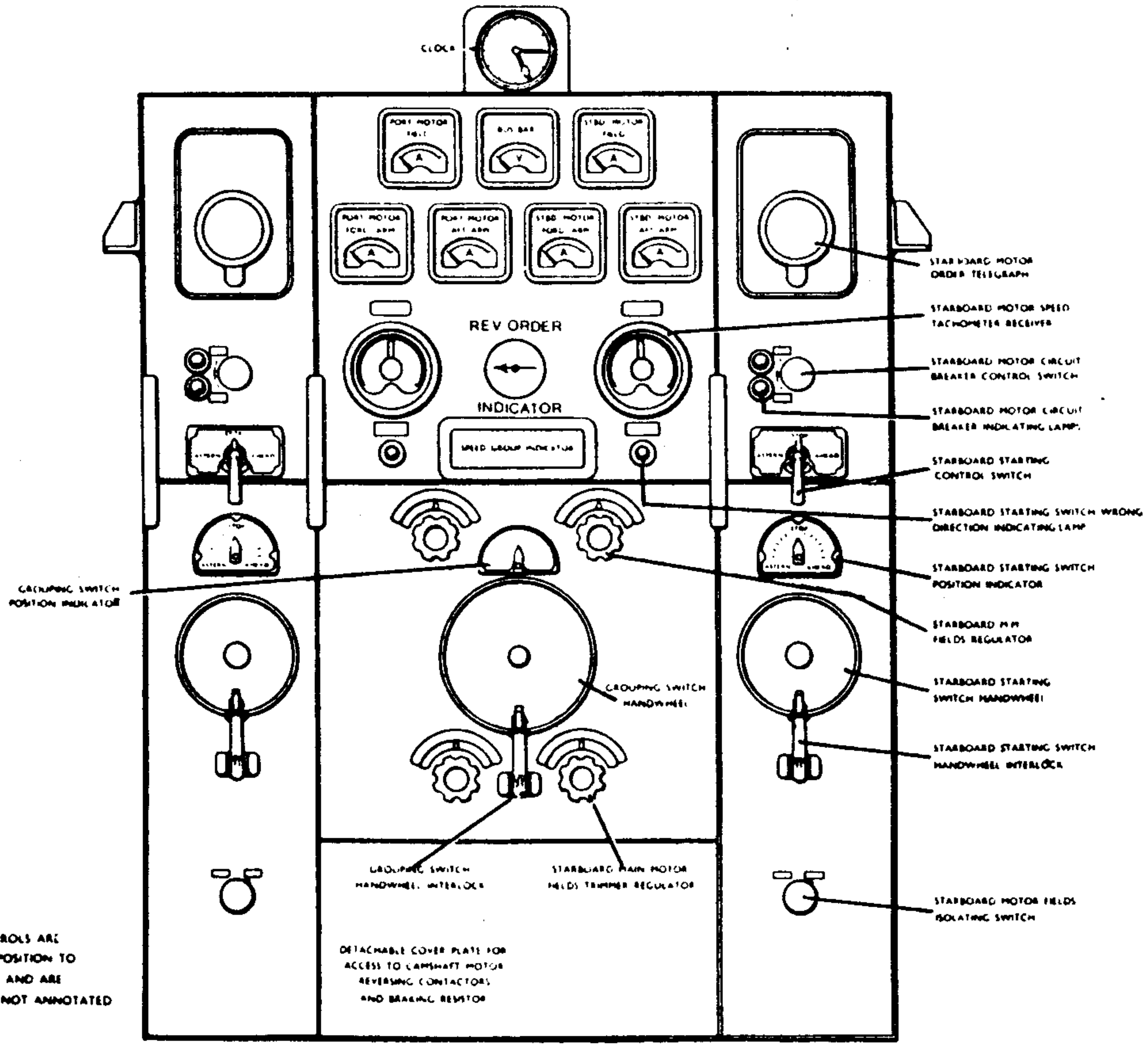
STARBOARD FRAME—REAR VIEW

LAYOUT OF MOTOR CIRCUIT BREAKER FRAMES

Fig. 2-21

Main Propulsion Switchboard




CLOCK
PORT MOTOR FIELD
STBD MOTOR FIELD
A
V
REV ORDER
INDICATOR
SPEED GROUP INDICATOR
STARBOARD MOTOR ORDER TELEGRAPH
STARBOARD MOTOR SPEED TACHOMETER RECEIVER
STARBOARD MOTOR CIRCUIT BREAKER CONTROL SWITCH
STARBOARD MOTOR CIRCUIT BREAKER INDICATING LAMPS
STARBOARD STARTING CONTROL SWITCH
STARBOARD STARTING SWITCH WRONG DIRECTION INDICATING LAMP
STARBOARD STARTING SWITCH POSITION INDICATOR
STARBOARD M.M. FIELDS REGULATOR
STARBOARD STARTING SWITCH HANDWHEEL
STARBOARD STARTING SWITCH HANDWHEEL INTERLOCK
STARBOARD MOTOR FIELDS ISOLATING SWITCH
GROUPING SWITCH POSITION INDICATOR
GROUPING SWITCH HANDWHEEL
GROUPING SWITCH HANDWHEEL INTERLOCK
STARBOARD MAIN MOTOR FIELDS TRIMMER REGULATOR
DETACHABLE COVER PLATE FOR ACCESS TO CAMSHAFT MOTOR REVERSING CONTACTORS AND BRAKING RESISTOR

NOTE
PORT CONTROLS ARE SIMILAR IN POSITION TO STARBOARD AND ARE THEREFORE NOT ANNOTATED

Principal controls and indication.

1. Direction of the port and stbd. main motors.
2. Main motor field current ammeters.
3. Individual main motor armature current ammeters.
4. Main power busbar voltmeter.
5. Port and stbd. main motor telegraphs and grouper telegraphs.
6. Port and stbd. main motor speed indication and rev. order indicator.
7. Port and stbd. main motor breaker controls and field isolating switches
8. Port and stbd. main motor field trimmer regulators.

39. The Main Propulsion Switchboard

This switchboard controls the main motor grouping and starting, and also the battery grouping. Components for the control of the starboard main motors are arranged on the right of the switchboard, and those for the port main motor on the left, when viewed from the front of the switchboard.

Control of the main motors is by means of:

a. The grouper handwheel.

b. The three position trigger switches.

The grouper handwheel turns two camshafts, one in the port main frame, and one in the starboard main frame. They connect the armatures as shown on page65 .

The three position trigger switch provides automatic starting and stopping of the main motor controllers. Putting the switch to AHEAD or ASTERN will cause a small motor (called the camshaft motor) to rotate; this motor then causes the main motor camshaft to rotate which in turn starts the main motors.

40. The Camshaft Motor (CSM)

Its purpose is to achieve rotation of the main motor starter camshafts.

The CSM controls the main motor starter camshafts, each starting step being maintained for one second. The rotary motion of the CSM is converted to a step by step movement on the starter camshaft by "GENEVA" gearing.

The shunt field of the CSM is energised via 60 amp control fuses (situated under the desk behind a panel at the main power switchboard) immediately the main power breakers are set. The CSM is controlled by the three position trigger switch mounted on the front of the main propulsion switchboard marked "ASTERN", "STOP", "AHEAD"

By controlling the direction of rotation of the CSM armature, effective starting control of main motors can be achieved.

41. Possible Faults that will Prevent CSM Starting

a. Main power breakers not set.

b. 60 amp control fuses blown or removed.

c. Grouper not in a definite group.

d. Main motor shunt field switch not made.

e. Handle of grouper not locked in down position.

f. Handle of emergency starter controller not locked in down position.

42. Hand Emergency Control of Starter Camshafts

An alternative drive is provided by a handwheel on the main propulsion switchboard. The handle is held down by a clip, and in being held down it presses an interlock switch which permits the CSM to run.

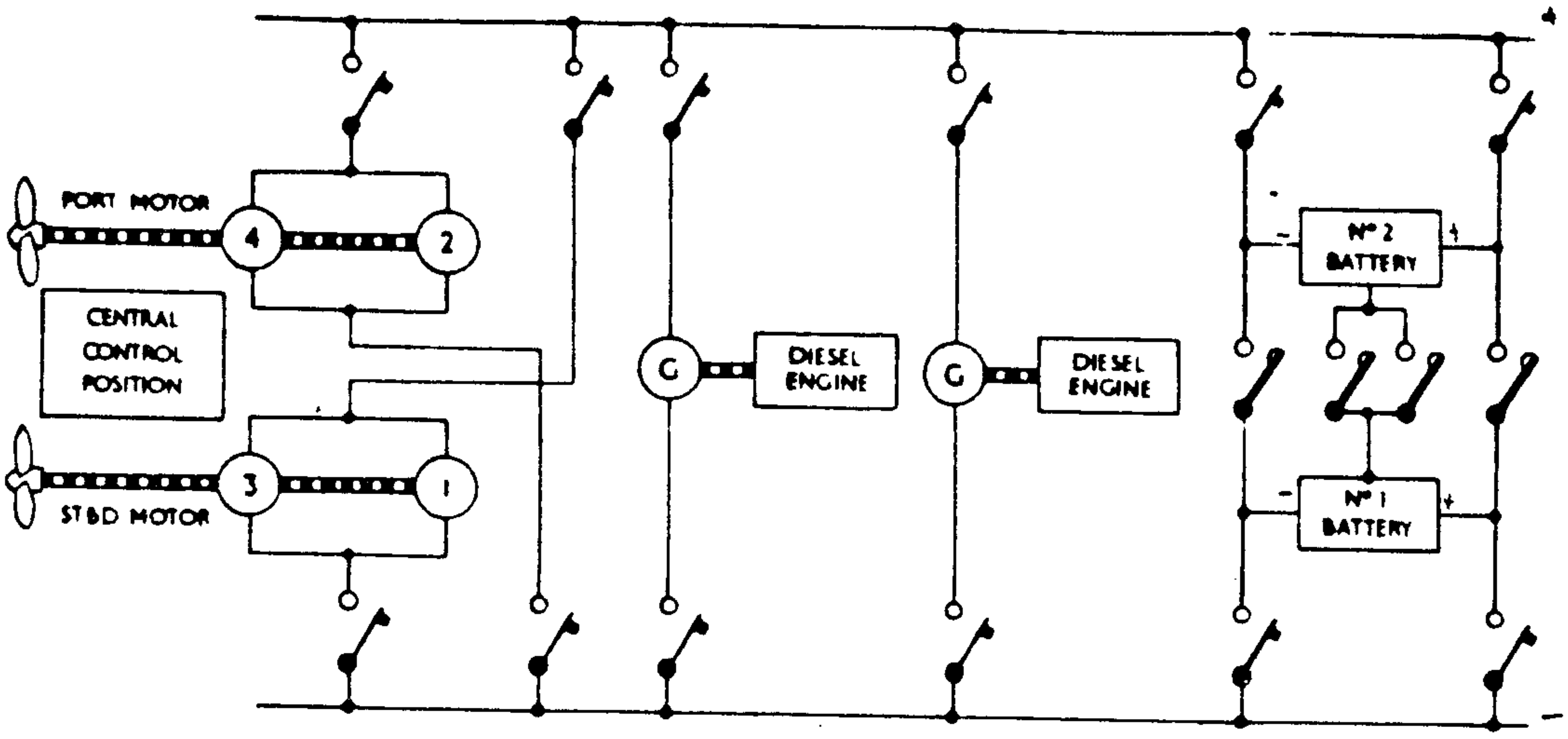
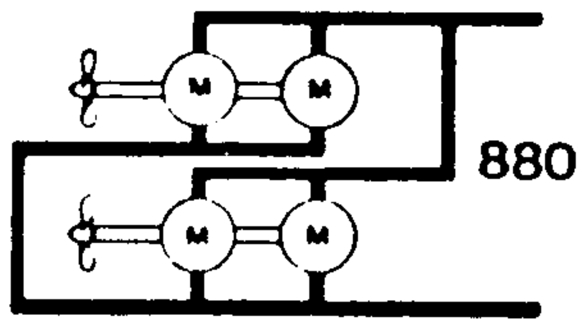
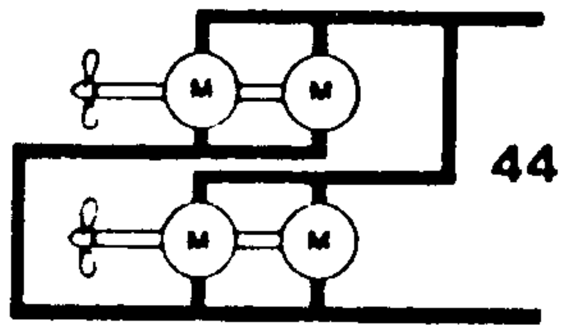
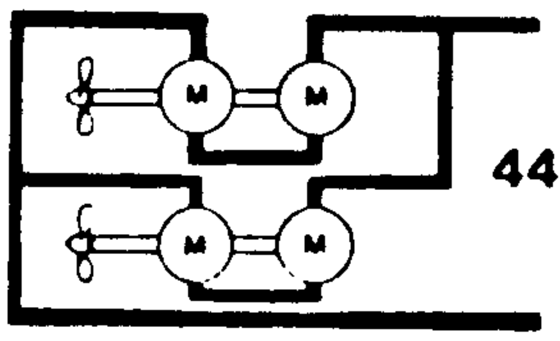
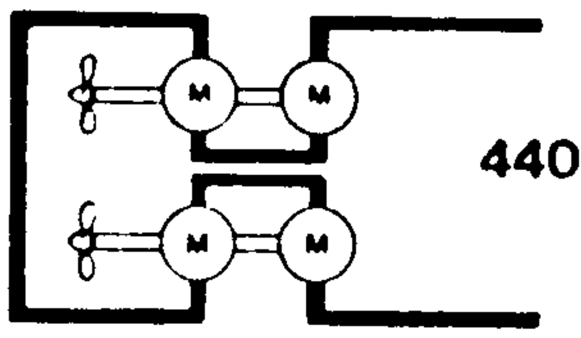


Fig 23 ELECTRICAL PROPULSION SYSTEM

ARMATURE CONNECTIONS	GROUP	R P M RANGE	NOTES
 880V	BATTERIES IN SERIES	325-400 STD ½ 350	1. Highest speed available 2. Unable to generate 3. Limited endurance-30 mins. 4. BHP per shaft 1650-3000 5. 880v each armature
 440V	GROUP UP	180-325 STD ½ 250	1. High speed 2. Normal surface group 3. Fast snort 4. BHP per shaft 273-1650 5. 440v each armature
 440V	GROUP DOWN	90-210 STD ½ 150	1. Medium speed 2. Normal dived group 3. Charging snort 4. BHP per shaft 35-300 5. 220v each armature
 440V	SHAFTS IN SERIES	45-100 STD ½ 75	1. Low speed 2. Seldom used 3. 110v each armature

43. Main Camshafts

Purpose - the operation of the main starting resistors.

Power is put onto the main motors through banks of starting resistors and heavy duty silver contactors. The contactors are operated by main camshafts in the main frames.

The camshafts are rotated by a camshaft driving motor (CSM). The motor transmits its torque through a friction clutch and Geneva gearwheel.

44. Camshaft Driving Motor

Purpose - rotation of main camshaft.

The field of the camshaft motor is energised immediately the main power breaker is set, through 60 amp fuses.

The camshaft is controlled by a three position trigger switch mounted on the propulsion switchboard, and electro-magnetic contacts. The switch is marked ASTERN-STOP-AHEAD. By controlling the direction of rotation and speed of the CSM armature, the effective starting control of the main motors can be achieved.

Supply to the CSM is available through 60 amp fuses when the main power breakers are set. The positive supply to CSM passes through BA3 contact, which is closed when the grouper is in a definite position. Then to contact PF5 which is closed when the port field switch is made, through W2 which is made when the handle of the grouper is locked down; then through PW1 which is closed when the emergency controller handwheel is locked down.

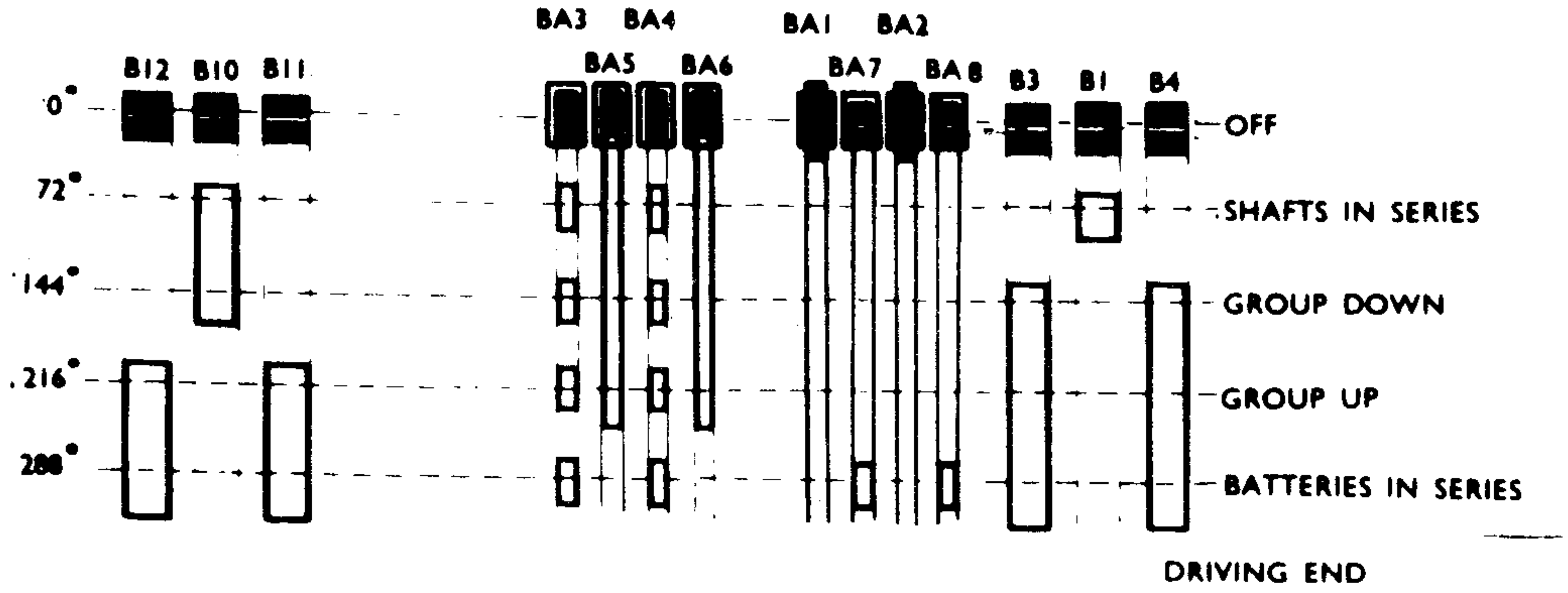
The positive supply is now available on contacts PC2 and PC3 which are contacts of the three position trigger switch and are closed whenever the trigger switch is in the STOP position. The positive supply is also available at PCF and PCR upper contacts in the CSM armature circuit.

To rotate the CSM for AHEAD running, the trigger switch is put to AHEAD. This opens PC3 contact and closes PC1 contact. PC2 remains closed and PC4 remains open. The PCF coil has then a return line through line PC7 and position regulator cams PA5, via contacts of CDM2 relay, if the trigger switch is changed whilst CSM is running. CDM prevents power being re-applied to the armature until it has come to rest. This point will become more clear after we have gone through the control sequence of the camshaft motor.

CSM field is energised immediately a main power breaker is set, through 60 amp fuses. CSM is controlled by 3 position trigger switch and electro-magnetic contacts. By controlling the direction and speed of the CSM, control of the main motors is achieved. Sequence is from positive:

BA3 - grouper in a definite position/group, other than OFF.
PF5 - closed when the port field is made.
W2 - grouper handle locked down.
PW1 - closed when emergency controller handwheel is locked down.

We now have a positive supply available on PC2 and PC3, which are contacts of the trigger switch and closed when the switch is in the STOP position. The supply also waits at PCF and PCR upper contacts in the CSM armature circuit.



DEVELOPMENT OF GROUPING SW. (PORT FRAME)

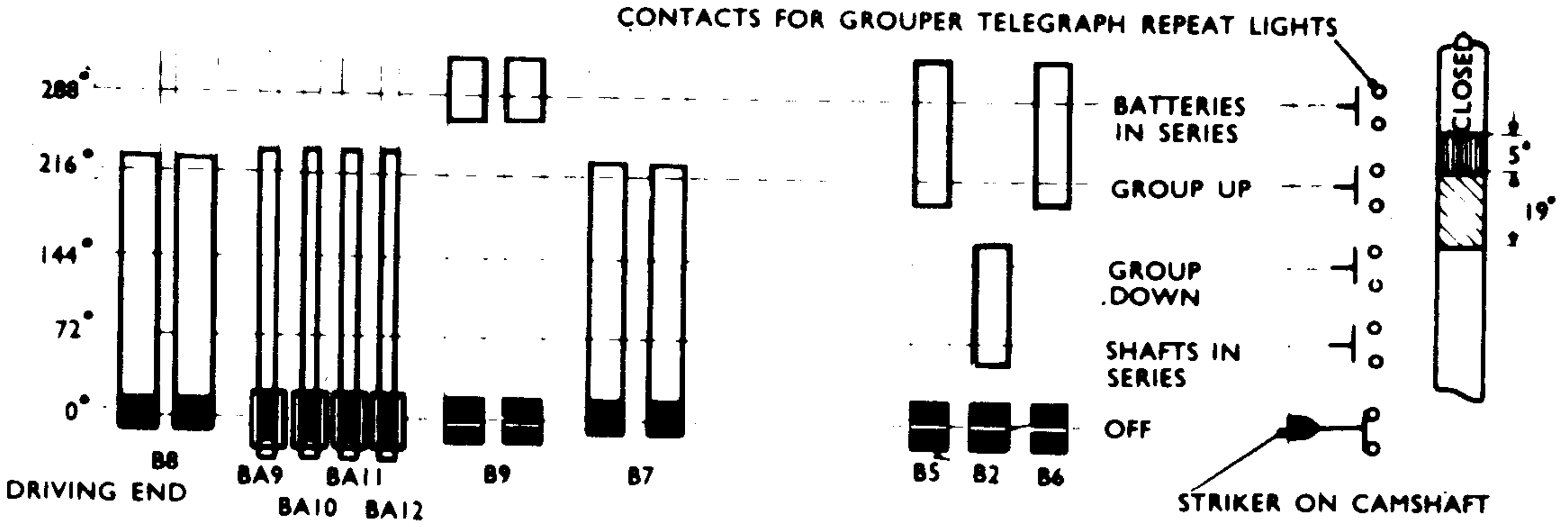


Fig 2-25 **DEVELOPMENT OF GROUPING SW. (STBD. FRAME)**

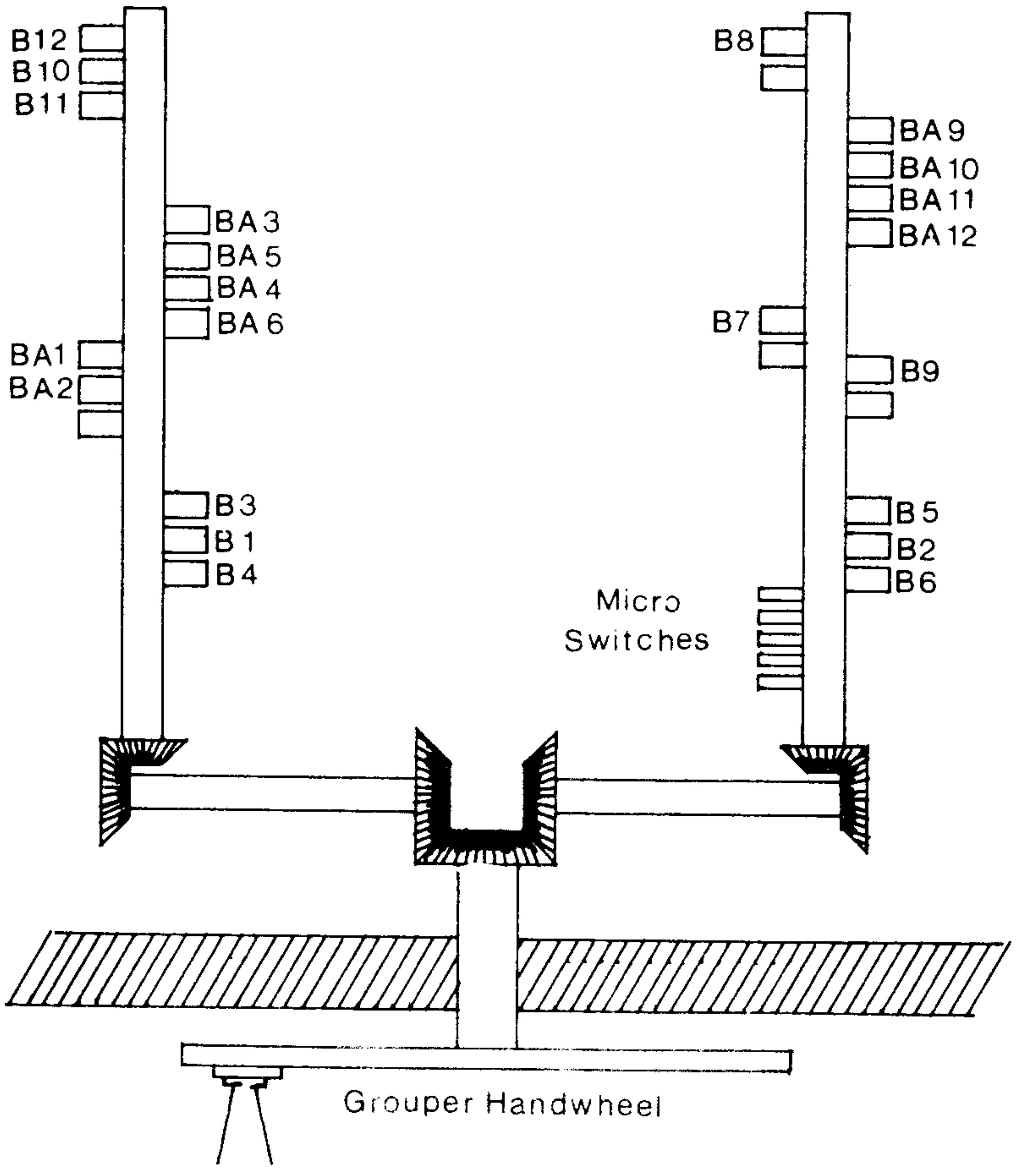
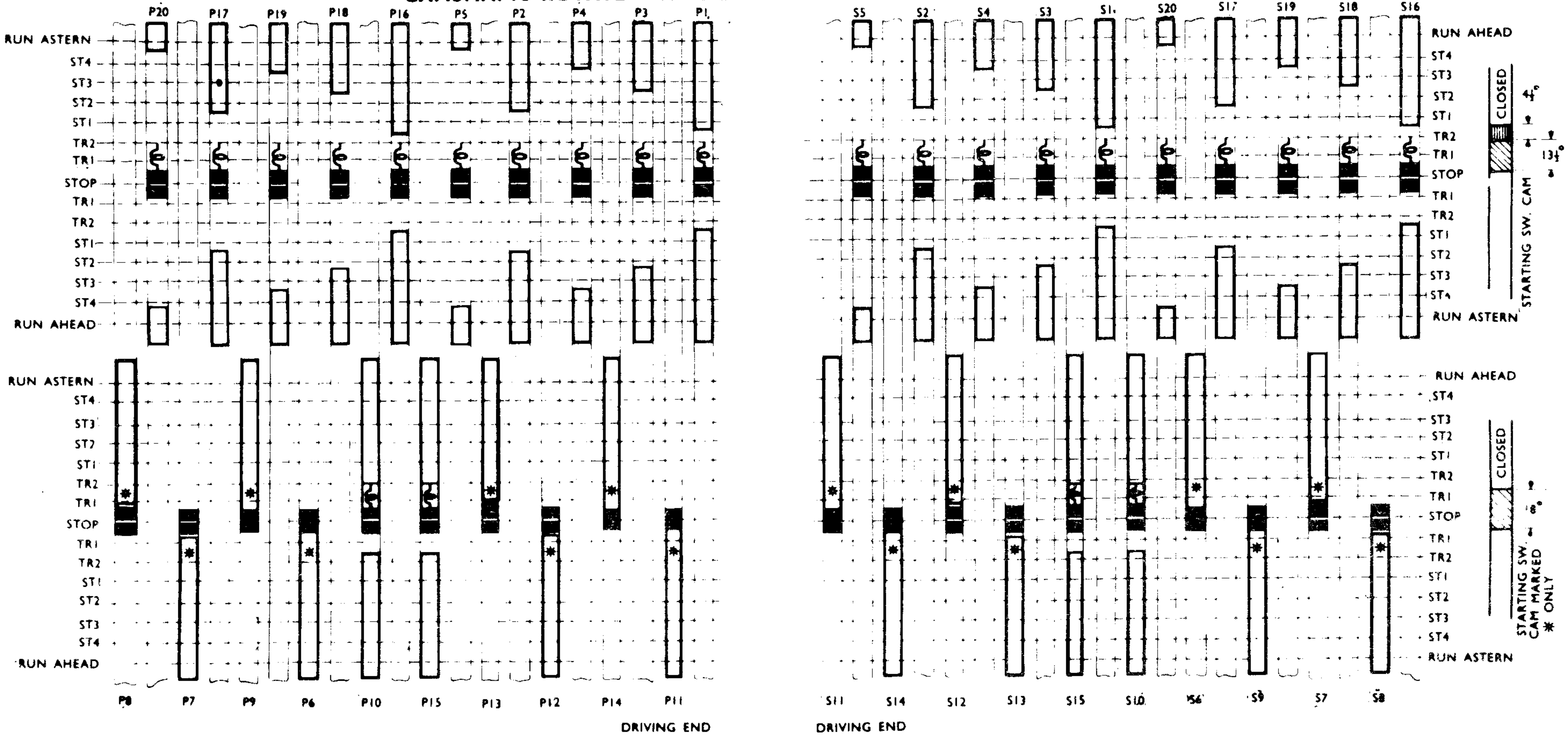


Fig 2-26 GROUPER SWITCH ARRANGEMENT

CAMSHAFTS ROTATE⌒AT D.E. FOR " OFF " TO BATTERIES IN SERIES



PORT STARTING SWITCH DEVELOPMENT

STARBOARD STARTING SWITCH DEVELOPMENT

CAMSHAFTS ROTATE⌒AT D.E. FOR ' AHEAD ' RUNNING OF MOTORS

CAMSHAFT DEVELOPMENT DIAGRAM FOR GROUPING AND STARTING SWITCHES

Fig 2-27

Put trigger switch to AHEAD:

PC1 closes
PC2 remains closed
PC3 opens
PC4 remains open

PCF energises via CMS2 contact, coil, PC1, line PC7 and position regulator cam PA5.

Upper and lower PCF contacts close in armature circuit.

Armature circuit completes via:

BA12 - closed unless grouper to batteries-in-series.
PW2 - controller emergency handwheel locked down.

Other PCF contacts operate as follows:

a. PCF contact to provide a retaining circuit for PCF coil. (The CSM energising will cause CMD2 relay to energise, thus opening the CMD2 contact in the PFC coil circuit.

b. PCF contact in series with a. will close in the CMR2 circuit and CME2 coil will energise via BA11 (closed if the grouper is away from BIS) and lines PC8, cam PA1 and line PC4.

The effect of CMR2 coil energising, causes a CMR2 contact in the field circuit to open, putting resistance PSZ in series with the field, thus speeding up the CSM. When the camshaft rotates to that point between positions TR1 and ST1, cam PA1 will cease to bridge for the energisation of CMR2 coil, which will become de-energised causing associated CMR2 contact in the field circuit to close, shorting out the series resistance, strengthening the field, and thus slowing the motor down. It will be seen by referring to the starting switch table, that it is at this point that current is initially applied to the main motor. Prior to this point, the camshaft is closing the armature contacts necessary to achieve AHEAD rotation. This operation is carried out with no power on the main motor armatures.

The energisation of CMD2 operates the following contacts:

a. CMD2 contact in the PCF coil circuit (already discussed).

b. Two CMD2 contacts in series in the field circuit close shorting CFZ2 resistance. The point of this resistance is to ensure that the camshaft motor field is not overheated when the motor is stopped and busbar volts exceed 500 V.

When the camshaft reaches the AHEAD position and the main motor starting sequence is complete, cam PA5 will open circuit the PCF coil, opening the UPPER and LOWER PCF contacts in the CSM armature circuit de-energising it. The PCF contact in parallel with the CSM armature will close, providing rheostatic breaking for the armature and stopping the armature. CMD2 relay immediately de-energises and its associated contacts in the field circuit insert the limiting resistance, thus reducing the static field current. The CMD2 contact in the PCF coil circuit will close. The PCF coil circuit will open. The PCF contacts in the CMR2 coil circuit will open.

To return from AHEAD to STOP:

Trigger switch to STOP
PC1 opens
PC2 remains closed
PC3 closes
PC4 remains open
PCR coil is now energised via line PC13 and cam PA3
PCR contacts will now close to cause the CSM to drive back to the STOP position.

CMR2 coil is energised via cam PA4 and the motor drives all the way back at its best speed.

CMD2 also operates, cutting out CFZ2 and opening the CMD2 contact in the PCR coil circuit.

When in BIS the contacts BA11 and BA12 are opened by the grouper, thus CMR2 cannot be energised and the CSM will run slowly over all steps. At the same time, BA12 being open inserts a resistance in series with CSM armature, slowing it down even further.

45. CMS2 Contact in the PCR Coil Circuit

If the position of the trigger switch is changed while the CSM is running CMD2 relay acts as an interlock and prevents power being re-applied to the armature until it has come to rest. This counters any tendency for the armature to flash over.

e.g. Suppose that the switch has been moved from AHEAD to OFF. PCR is energised and CMR2 is energised via PA4, so the motor is running at full speed. If the switch is now returned to AHEAD, PC3 is opened thus de-energising PCR and CMR2. The armature is disconnected from its supply and connected to the breaking circuit; full field is produced so full braking torque is applied. Although PC1 was made at the same time as PC3 opened, PCF is NOT energised until the breaking torque has brought the motor to rest and CMD2 has de-energised. The CSM is then automatically started in the AHEAD direction on full field, reverting to weak field if the regulator position is between TR2 and OFF as for normal start.

When in BIS the contacts BA11 and BA12 are opened by the grouper, thus CMR2 cannot be energised and the CSM will run slowly over all steps. At the same time, BA12 being open inserts a resistance in series with CSM armature, slowing it down even further.

46. Position Regulator Cams

Purpose - completion of circuits for CSM and operating circuits for breakers.

P or S - A1 - decreases the CSM speed on start to run ahead steps.

" - A2 - stops the CSM when the run astern position is reached.

" - A3 - stops the CSM at off, when coming back from run ahead position.

" - A4 - decreases CSM speed on start to run astern steps.

" - A5 - stops the CSM when run ahead position is reached.

" - A6 - stops the CSM at OFF when coming back from astern.

" - A7 - not used.

" - A8) - prevents MP breakers being set when controllers are away from
A9) OFF and bus-bars are dead.

" - A10 - prevents MM breakers being set when controllers are away from OFF.

" - A11 - used in conjunction with an order telegraph in the control room to light a wrong direction lamp in the motor room, if the camshaft is rotated for a direction at variance with that ordered by the telegraph.

The main motor shunt fields of each motor are fed in series across 440 V from the main power bus-bars, so that regardless of the position of the grouper they are always fed with 440 V. The fields are connected in series so that each field has 220 V across them. Maximum shunt field current 35 amps.

47. Field Controls

a. Shunt Field Switch. Situated on the front of the main propulsion switchboard at the bottom port and starboard, marked "IN/OUT".

b. Field Changeover Switches (CO1 and CO3). These switches are situated in the starboard main frame below the starboard main motor circuit breaker. They are used for defective field routine.

48. Defective Field Routine

This is restricted to the starboard side only.

a. Stop both motors.

b. Open field switch.

c. Trip motor breaker and both main power breakers.

d. Remove defective motor armature links and replace nuts and locking plates.

e. Check blower COS is set to healthy armature.

f. Change defective field COS to down position.

g. Close one or both main power breakers.

h. Close field switch and check current.

i. Close main motor breaker.

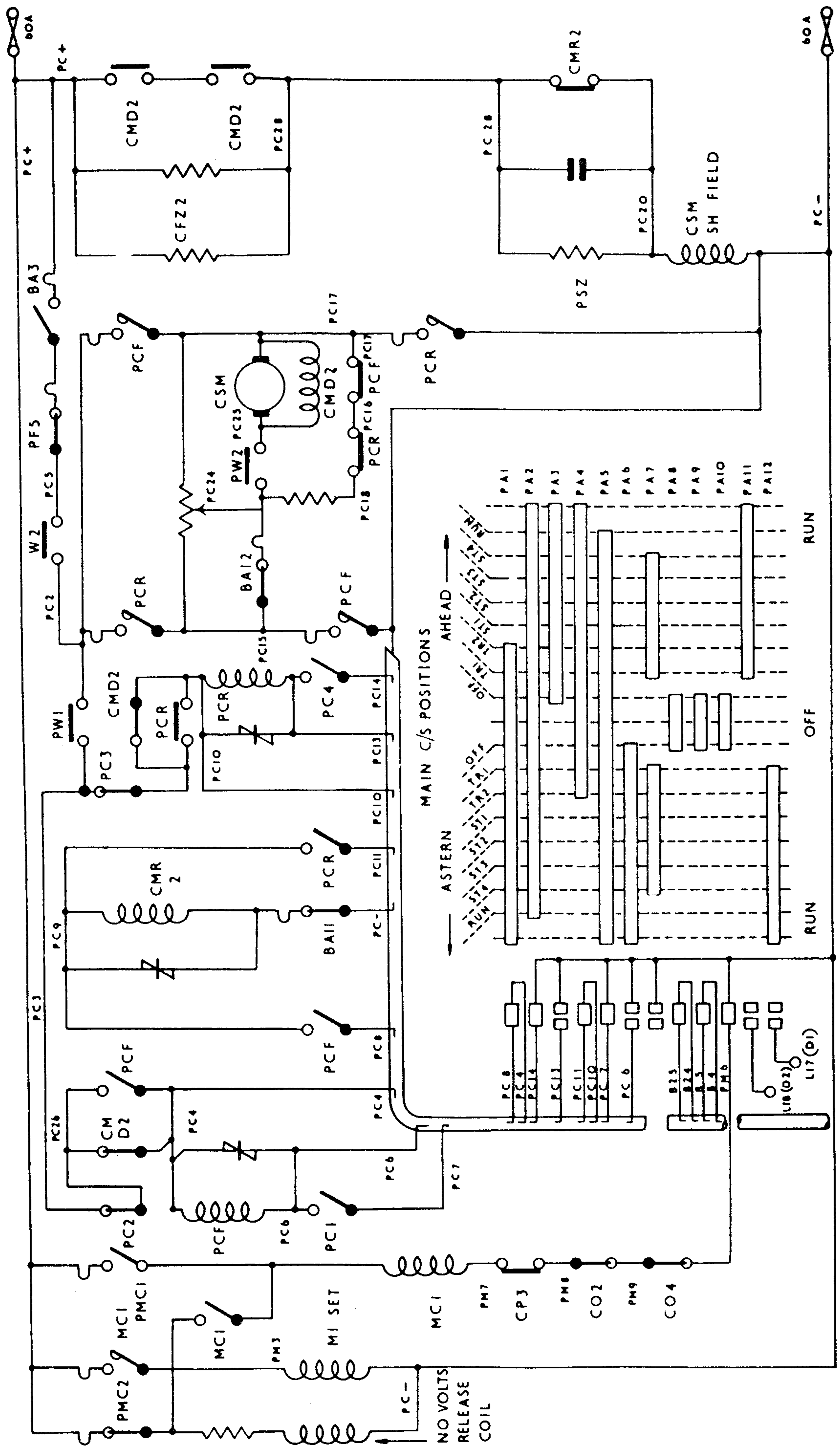
j. Engage "Group Up" only.

k. Report to control room "STARBOARD MAIN MOTOR READY TO PROPEL FOR'D/AFTER ARMATURE".

NOTE: Field Changeover Switches

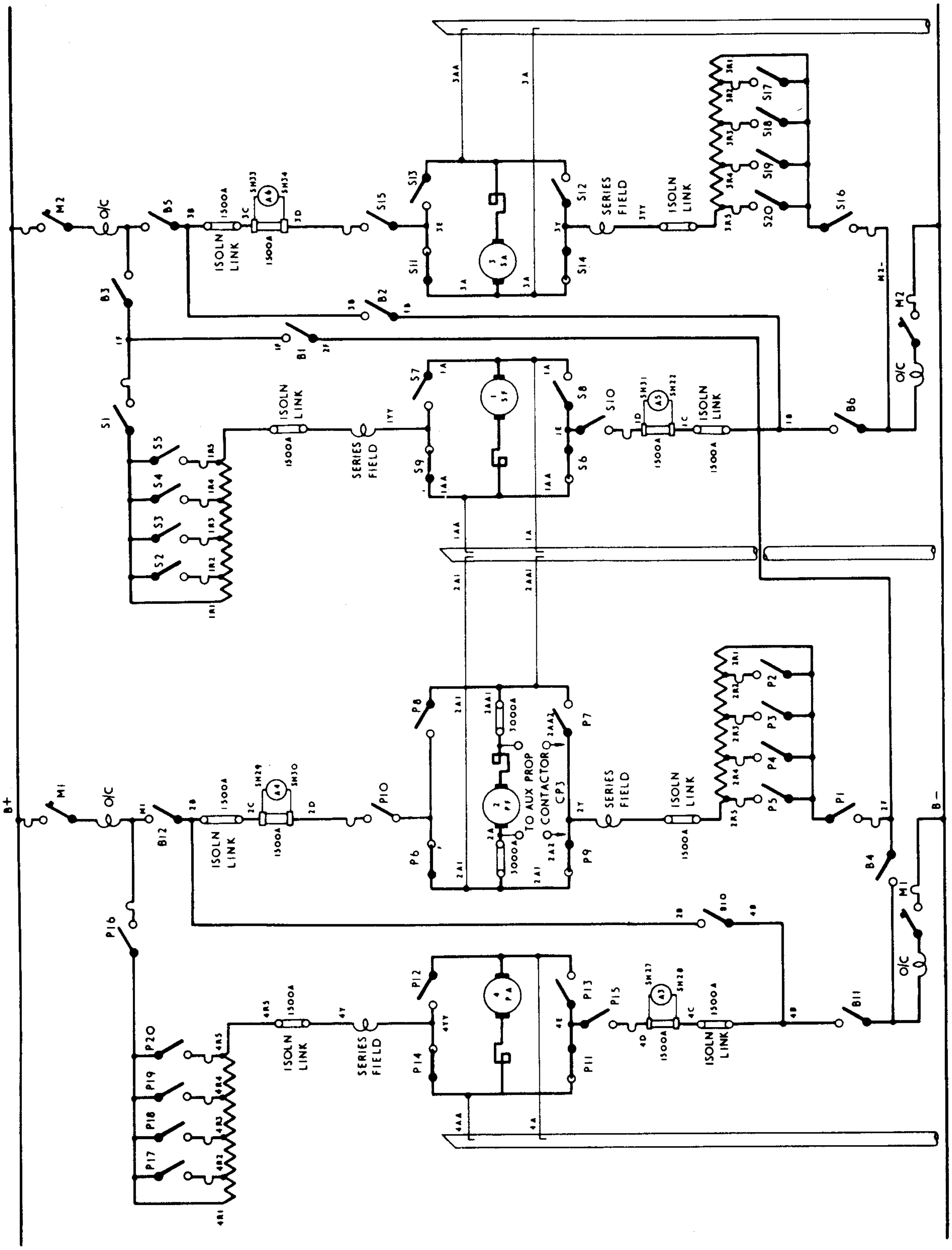
There are similar COS in the port main frame but these are wired to facilitate auxiliary drive (see Main Propulsion circuit).

"No Chief, not back to sea..... again!"



MAIN MOTOR CONTROL CIRCUITS

Fig 2-28



MAIN MOTOR CIRCUITS

Fig 2-29

49. Mechanical Interlocks

Purpose - protection of electrical switchgear. Figure 5.3 BR 1964(19A).

a. Between starter camshaft and grouper camshaft.
To ensure that power is taken off MM before any re-grouping can take place. Also to ensure that a group is correctly located before starting camshaft can be moved.

b. Between starter camshaft and field switch.
To ensure that the field switch is made before the main camshaft can rotate. Also to ensure that field switch cannot be broken when the starter camshaft is away from the OFF position.

50. Electrical Interlocks

Handout - Main Propulsion.

a. Camshaft driving motor interlocks.
(Port camshaft, BA3, PF4, PW1 and PW2, BA11, BA12, W1)
(Stbd camshaft, BA4, SF5, SW1 and SW2, BA9, BA10, W1)

b. BA1 and BA2.
To ensure that the generator breakers cannot be set onto dead bus-bars unless the grouper switch is in the OFF position.

c. VS5 and VS6.
To ensure that the generator breakers cannot be set unless the voltmeter selector switch is to the oncoming generator.

d. BA5 and BA6.

To ensure that the generator breakers cannot be set when the grouper switch is to batteries-in-series. Also if the generator breakers are set, putting the grouper to batteries-in-series will trip the generator breakers.

e. The mid-point linking switch must be fully closed before the main and auxiliary breakers can be set. Also when the auxiliary breakers are set, opening the mid-point link switch will trip them.

f. The main power breakers cannot be set onto dead bus-bars unless both the MM camshafts are to OFF. (Contacts A8 and A9 on pos reg camshaft.)

SUBMARINE SWITCHGEAR - FUNCTION OF INTERLOCKS

Interlock	Circuit	Function
VS5 VS6 VS1'2- VS3'4	Port Generator C'B Stbd Generator C'B Generator Voltmeters	Ensures that the voltmeter is for the generator about to be switched onto line.
NVR2.BA1 NVR1.BA2	Port Generator C'B Stbd Generator C'B	Considering the interlocks separately then BA1'2 prevents closure of C'B if GROUPER is away from OFF. NVR2'1 prevents closure of C'B onto dead busbars. Considering the interlocks together the function is as follows: If the Port Generator is closed on to line and motor circuits set up then BA1 and 2 will be open and NVR1 and 2 will be closed. It is permissible to close Starboard Generator on to line using the normal parallelling procedure under these circumstances NVR1 is necessary to by-pass BA2 thus allowing stbd C'B to be closed.
CC1 CC2	Port Generator C'B Stbd Generator C'B	Normal function of C'B closing circuit is: C'B switch in SET position. CC1 coil energised. CC1 main contacts close in main C'B closing coil circuit. C'B switch released to OFF. CC1 coil holding via CC1 aux contactor in series with C'B switch TRIP contacts. C'B closes - CC1 contacts mechanically open. Should the C'B jam mechanically in half closed position then CC1 fails to be mechanically tripped and therefore CC1 coil may burn out. Placing C'B switch to TRIP allows CC1 coil circuit to be broken.
BA5 BA6	Port Generator C'B Stbd Generator C'B	Prevents Generator C'B being closed when GROUPER is in Batteries-in-Series position. BA5/6 are aux contacts on the GROUPER and are in C'B No Volt Close coil circuit.
CP3	Port Motor C'B	Port shaft is used for AUXILIARY PROPULSION and CP3 is the Auxiliary Propulsion power contactor. If CP3 is closed, the Port Motor C'B cannot be closed.
MC1 MC2	Port Motor C'B Stbd Motor C'B	Function as for CC1'2 in Generator C'B circuits.
PA10 SA10	Port Motor 'B	Motor C'Bs cannot be closed if the Position Regulators are away from the OFF position.
CO2-CO4	Port Motor C'B	These are knife type isolating switches. When running in AUXILIARY PROPULSION both switches are thrown to isolate the No. 2 Port Motor field from normal supply and connect for manual field control. If CO2-CO4 are open, Port Motor C'B cannot be closed.

Interlock	Circuit	Function
NVR1.PAB8 SA8 NVR2.PA9 SA9	No, 1 Power C'B	If both Power C'B are open, NVR1-2 will be open and if either Power C'B is to be closed it is necessary to have both Position Regulators in the OFF position. Closing either Power C'B will cause NVR1-2 to close. Motor circuits can be set up and the normal battery parallelling sequence can be carried out i.e. the second Power C'B can be closed even though the Position Regulator is away from OFF because NVR contacts by-pass the Position Regulator contacts PA8-SA8 and PA9-SA9.
MPS1 MPS2	No. 1 Power C'B No. 2 Power C'B	The Power C'Bs cannot be closed if the batteries are split for any reason.
CC3 CC4	No. 1 Power C'B No. 2 Power C'B	Function as for CC1'2 in the Generator C'B circuit.
MPS1 MPS2	No. 1 Aux Power C'B No. 2 Aux Power C'B	The Auxiliary Power C'B cannot be closed if the batteries are split for any reason.
ACC1 ACC2	No. 1 Aux Power C'B No. 2 Aux Power C'B	Functions as for CC1'2 in Generator C'B circuits.
BA3 BA4	Port Camshaft Motor Stbd Camshaft Motor	GROUPER must be in a definite position (not OFF) i.e.: if between set-up positions the camshaft motor cannot be started.
PF5 SF5	Port Camshaft Motor Stbd Camshaft Motor	Camshaft motor cannot be run if main motor fields are isolated.
W2 W1	Port Camshaft Motor Stbd Camshaft Motor	Camshaft motor cannot be run if GROUPER handle is not housed.
PW1 SW1	Port Camshaft Motor Stbd Camshaft Motor	Camshaft motor cannot run if STARTING SWITCH handles are not housed.
PA2 SA2	Port Camshaft Motor Stbd Camshaft Motor	These contacts drop out ASTERN running coil when POSITION REGULATOR reaches Full Astern position.
PA4-PCR SA4-SCR	Port Camshaft Motor Stbd Camshaft Motor	These contacts are in the Camshaft Motor Relay circuit and cause the camshaft motor to run in weak field for the first two POSITION REGULATOR steps (Astern running).
PA6 SA6	Port Camshaft Motor Stbd Camshaft Motor	If Auto-Starting switch is turned from ASTERN to OFF these contacts will pick up the FORWARD running coil until OFF is reached. (Run back in weak field - PA1'SA1).
PA5 SA5	Port Camshaft Motor Stbd Camshaft Motor	If Auto Starting switch is turned from ASTERN to AHEAD these contacts will pick up the FORWARD running coil until AHEAD is reached. Also when moving Auto Starting switch from OFF to AHEAD these contacts drop our AHEAD running coil when POSITION REGULATOR reaches the Full Ahead position.

Interlock	Circuit	Function
PA3 SA3	Port Camshaft Motor Stbd Camshaft Motor	If Auto Starting switch is turned from AHEAD to OFF these contacts will pick up the ASTERN running coil until OFF is reached. (Run back in weak field - PA4'SA4).
PA1-PCF SA1-SCF	Port Camshaft Motor Stbd Camshaft Motor	These contacts are in the camshaft motor relay circuit and cause the camshaft motor to run in weak field for the first two POSITION REGULATOR steps (AHEAD RUNNING).
BA11(Port) BA9 (Stbd)	Camshaft Motor Relay Camshaft Motor Relay	When GROUPER is in Batteries-in-Series the camshaft motor cannot run in weak field.
CMR2 CMR1	Port Camshaft Motor Field Stbd Camshaft Motor Field	When camshaft motor relay is energised, a section of resistance is placed in series with the camshaft motor field to provide a weak field.
PCF/PCR SCF'SCR	Port Camshaft Motor Relay (CMR2) Stbd Camshaft Motor Relay (CMR1)	When these contacts are closed, the camshaft motor runs in a weak field. (Except in Batteries-in-Series - see BA11'BA9).
PCF'PCR SCF'SCR	Port Camshaft Motor Stbd Camshaft Motor	These contacts connect a breaking circuit across the motor armature.
BA12 BA10	Port Camshaft Motor Stbd Camshaft Motor	When GROUPER is in Batteries-in-Series their contacts open to insert resistance in series with the motor armature and so reduce running speed.
PW2 SN2	Poet Camshaft Motor Stbd Camshaft Motor	These are Starting switch handwheel interlocks - Camshaft motor will not run unless wheel handle is housed.

Modified Camshaft Motor Circuit:

The Camshaft motor field is permanently connected across the supply and past experience has shown that the field coils deteriorate due to overheating. Also, if the camshaft motor was reversed during the short period of weak field running, a tendency to flashover existed. To overcome these defects:

a. Extra resistance has been inserted in the motor field circuit.

b. A relay has been inserted across the motor armature to sense rotation. The relay CMD1'2 has contacts in the PCF'PCR coil circuit (in parallel with PCF'PCR contacts) and also across the new resistance to short this out of circuit.

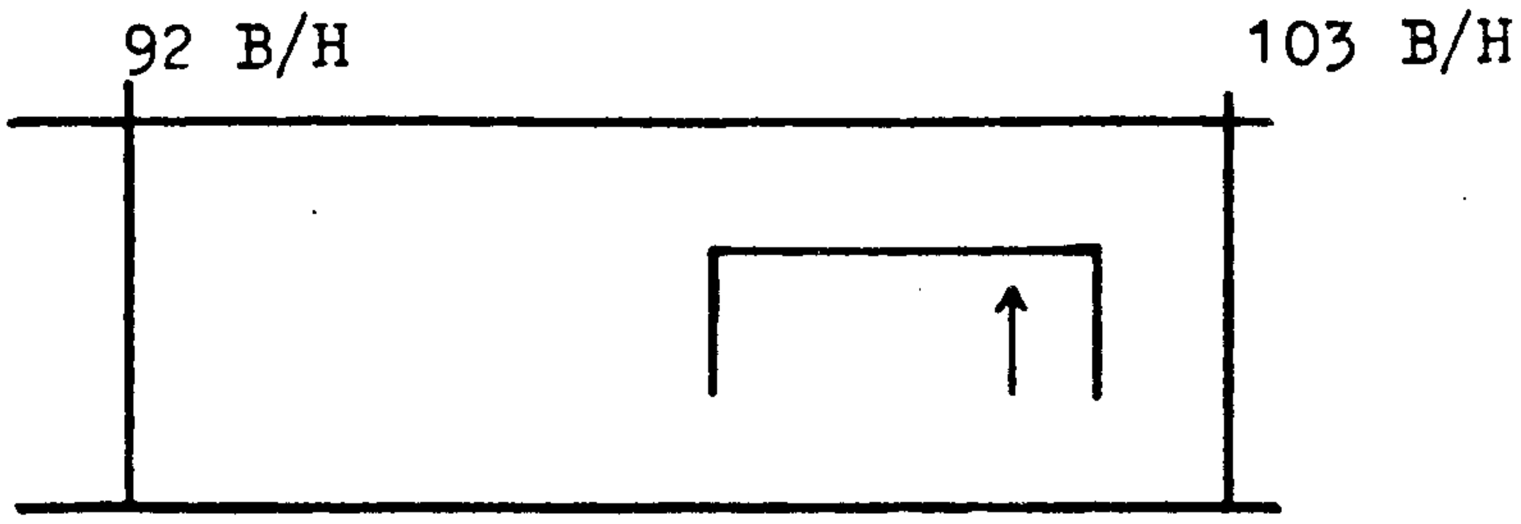
Interlock	Circuit	Function
CMD2 CMD1	Port Camshaft Motor Field Stbd Camshaft Motor Field	When the camshaft motor is running, these contacts short out a section of resistance in series with the motor field. When the motor stops, this resistance reduces the standing field current.
CMD2.PCR' PCF CMD1.SCR' SCF		Relay CMD1'2 is across the camshaft motor armature and consequently is only energised when the armature is fed. The AHEAD and ASTERN (PCF'SCF-PCR'SCR) running coils each have contacts of CMD in parallel with their own interlocks inserted in series with the coils. Taking one coil circuit as an example: CMD2 is normally closed in PCF coil circuit. PCF contacts are open in PCF coil circuit. Place Auto-Start switch in AHEAD position - PCF picks up via N'C CMD2 contacts. PCF main contacts close in armature circuit and auxiliary contacts confirm PCF coil circuit. CMD2 relay picks up and CMD2 contacts open in PCF coil circuit to leave PCF retained on its own interlocks. When switching from AHEAD to OFF or ASTERN: PCF drops out but CMD2 holds on until the motor armature stops rotating. It is therefore impossible to reverse the motor while it is still running.
MPS1. MPS1.	CP Ring Main CPA CP Ring Main CPB	Only one half of No. 1 Battery can be in use to supply the CP Ring Main. CPA and CPB are across separate halves of the battery.
CP2	CP Ring Main CPA	If No. 2 DC'DC MG Set is running and the selector switch is moved to pick up CPA, it is necessary to ensure that CP2 is out before CPA picks up. These contacts in CPA coil circuit ensure this condition.
RM1.MGZ1	No. 1 DC'DC MG Set	MGZ1 contacts are on the hand operated speed regulator and ensure that the motor starts in full field. RM1 contacts maintain the start and Run circuits when the speed regulator is moved from full field position and the starting switch is moved from the start position.
OSR2 OSR2 override	No. 1 DC'DC MG Set	OSR2 Override button closes the OSR1 coil circuit unto the set has run up to speed and the OSR2 contacts have closed. OSR2 relay contacts (Saunders) close to hold the OSR1 coil circuit when the set has run up to speed.
VR1	No. 1 DC'DC MG Set	OVR1 contacts in OSR1 coil circuit protect against over-voltage. CP1, SM1 and RM1 contactors will drop out if OVR1 (or OSR2) operates.

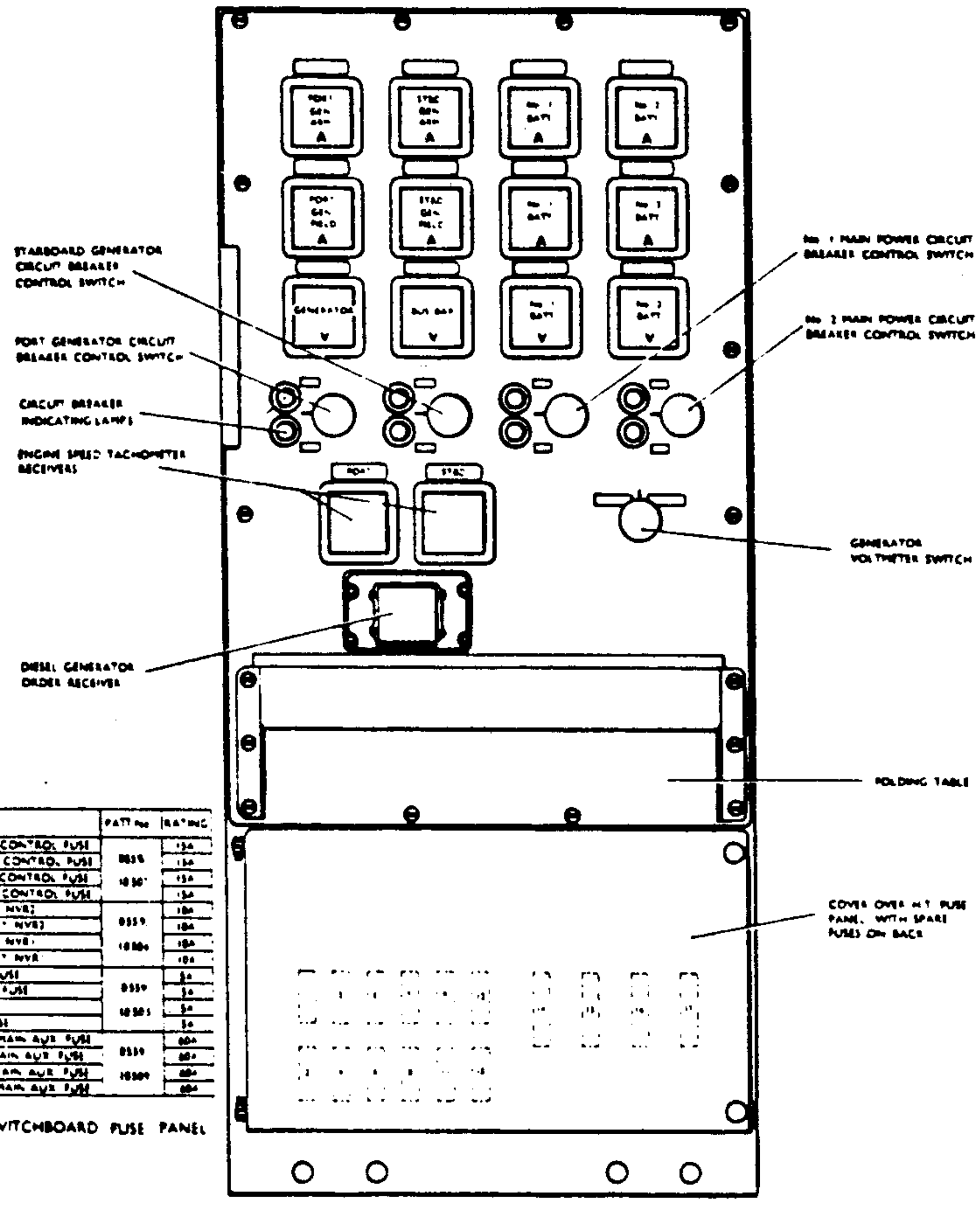
Interlock	Circuit	Function
OSR1	No. 1 DC'DC MG Set	Since over'under speed or over voltage relays drop out OSR1 relay these contacts control CP1, SM1, RM1 coil circuit.
SM1	No. 1 DC'DC MG Set	These contacts close in the 'RUN' RM1 contactor coil circuit, but the 'START' contactor (SM1) power circuit is via a series coil on RM1 and this holds off RM1 until the starting current has fallen to a pre-set value.
SM1	No. 1 DC'DC MG Set Exciter	These contacts close the exciter field circuit when the MG Set contactor SM1 is closed.
CCB1.CP1	No. 1 DC'DC MG Set	CCB1 is a push button used to close CP1 (G1 output contactor). CP1 coil circuit is a self-retaining circuit and has CP1 interlocks in parallel with CCB1 to hold the coil circuits once made.
RM2.MG22	No. 2 DC'DC MG Set	Function as for No. 1 DC'DC MG Set.
OSR4 OSR4 over ride	No. 2 DC'DC MG Set	Function as for No. 1 DC'DC MG Set (OSR3).
OVR2	No. 2 DC'DC MG Set	Function as for No. 1 DC'DC MG Set (CP2, SM2, RM2).
OSR3	No. 2DC'DC MG Set	Function as for No. 1 DC'DC MG Set (CP2, SM2, RM2).
SM2	No. 2 DC'DC MG Set	Function as for No. 1 DC'DC MG Set (RM2).
SM2	No. 2 DC'DC MG Set Exciter	Function as for No. 1 DC'DC MG Set (RM2).
CCB2.CP2	No. 2 DC'DC MG Set	Function as for No. 1 DC'DC MG Set (CP2).
CPA	No. 2 DC'DC MG Set	No. 2 DC'DC Set generator cannot supply the CP Ring Main if CPA is closed because CP2 cannot close.
CP3		No. 2 DC'DC Set generator cannot supply the CP Ring Main when No. 2 set is being used Auxiliary Propulsion because CP2 cannot close.
RM3.MGZ3	No. 3 400 Hz MG Set	Function as for No. 1 DC'DC MG Set.
OSR6. OSR6 over ride	No. 3 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (OSRS).
OSR5	No. 3 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (AC3, SM3, RM3).
SM3	No. 3 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (RM3).

Interlock	Circuit	Function
SM3	No. 3 400 Hz MG Set Exciter	Function as for No. 1 DC'DC MG Set Exciter (SM3).
AC7.AC4	No. 3 400 Hz MG Set	If No. 3 MG Set is used to supply both halves of the 400 Hz Ring Main, it is necessary to close interconnector contactor AC7. The interlock on AC7 opens and AC3 contactor holds through AC4 interlock. Thus No. 4 400 Hz MG Set cannot be used if No. 3 set runs and the interconnectors are closed i.e. the sets cannot be paralleled.
RM4.MGZ4	No. 4 400 Hz MG Set	Function as for No. 1 DC'DC MG Set.
OSR8 OSR8 Over ride	No. 4 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (OSR 7).
OSR7	No. 4 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (AC4, SM4, RM4).
SM4	No. 4 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (RMA).
SM4	No. 4 400 Hz MG Set	Function as for No. 1 DC'DC MG Set (SM4).
AC7.AC3	No. 4 400 Hz MG Set	Protects No. 4 400 Hz MG Set in the manner described for AC7. AC4 No. 3 MG Set.
RM5.MGZ5	No. 5 60 Hz MG Set	Function as for No. 1 DC'DC MG Set.
OSR 10 OSR10 over ride	No. 5 60 Hz MG Set	Function as for No. 1 DC'DC MG Set (OSR9).
OVR5	No. 5 60 Hz MG Set	Function as for No. 1 DC'DC MG Set (AC5, SM5, RM5).
OSR9	No. 5 60 Hz MG Set	Function as for No. 1 DC'DC MG Set (AC5, SM5, RM5).
SM5	No. 5 60 Hz MG Set	Function as for No. 1 DC'DC MG Set (RM5).
SM5	No. 5 60 Hz MG Set Exciter	Function as for No. 1 DC'DC MG Set exciter (SM5).
AC8.AC6		Protects No. 5 MG Set in the manner described for AC7.AC4 No. 3 MG Set.
RM6.MGZ6	No. 6 60 Hz MG Set	Function as for No. 1 DC'DC MG Set.
OSR 12 OSR 12 over ride	No. 6 60 Hz MG Set	Function as for No. 1 DC'MG Set (OSR 11).

Interlock	Circuit	Function
OVR 6	No. 6 60 Hz MG Set	Functions as for No. 1 DC'DC MG Set (AC6, SM6, RM6).
OSR 11	No. 6 60 Hz MG Set	Functions as for No. 1 DC'DC MG Set (AC6, SM6, RM6).
SM 6	No. 6 60 Hz MG Set	Functions as for No. 1 DC'DC MG Set (RMG).
SM 6	No. 6 60 Hz MG Set Exciter	Functions as for No. 1 DC'DC MG Set Exciter (SM6).
AC8.AC5	No. 6 60 Hz MG Set	Protects No. 6 MG Set in the manner described for AC7.AC4 No. 3 MG Set.
AC3.AC4	AC7 Interconnecting Contactor	Prevents No. 3 and No. 4'400 Hz MG Sets from parallelling.
AC5.AC6	AC8 Interconnecting Contactor	Prevents No. 5 and No. 6 60 Hz MG Sets from parallelling.
V151.V152	VP1 Contactor Control Control	Operated by VP2 contactor isolating links, VP1 and VP2 contactors are interlocked against both running togehter, therefore, if VP1 is closed, it has live circuits via VP2 interlocks. To allow work to be carried out on VP2, the isolating links are withdrawn and V151 and V152 provide a by-pass path for VP1 control circuit. VP2 interlocks are isolated and it is safe to work on the VP2 contactor.
VP2	VP1 Contactor Control Control	VP1 cannot be closed if VP2 is closed.
V153.V154	VP2 Contactor Control	As for V151-V152 except vice versa.
VP1	VP2 Contactor Control	VP2 cannot be closed if VP1 is closed.

Main power switchboard




STARBOARD GENERATOR CIRCUIT BREAKER CONTROL SWITCH
PORT GENERATOR CIRCUIT BREAKER CONTROL SWITCH
CIRCUIT BREAKER INDICATING LAMPS
ENGINE SPEED TACHOMETER RECEIVERS
DIESEL GENERATOR ORDER RECEIVER
No. 1 MAIN POWER CIRCUIT BREAKER CONTROL SWITCH
No. 2 MAIN POWER CIRCUIT BREAKER CONTROL SWITCH
GENERATOR VOLTMETER SWITCH
FOLDING TABLE
COVER OVER M.T. FUSE PANEL, WITH SPARE FUSES ON BACK
PORT
STBD

FUSE No	DESCRIPTION	PATT No	RATING
1	STBD GEN CIRCUIT BREAKER POS CONTROL FUSE	8515 10507	15A
2	STBD GEN CIRCUIT BREAKER NEG CONTROL FUSE		15A
3	PORT GEN CIRCUIT BREAKER POS CONTROL FUSE		15A
4	PORT GEN CIRCUIT BREAKER NEG CONTROL FUSE		15A
5	POSITIVE FUSE FOR NO VOLT RELAY NVR2	8559 10806	10A
6	NEGATIVE FUSE FOR NO VOLT RELAY NVR2		10A
7	POSITIVE FUSE FOR NO VOLT RELAY NVR1		10A
8	NEGATIVE FUSE FOR NO VOLT RELAY NVR		10A
9	GENERATOR VOLTMETER POSITIVE FUSE	8559 10505	5A
11	GENERATOR VOLTMETER NEGATIVE FUSE		5A
12	BATTERY VOLTMETER POSITIVE FUSE		5A
13	BATTERY VOLTMETER NEGATIVE FUSE		5A
14	STBD CONTROL SUPPLY NEGATIVE MAIN AUX FUSE	8559 10509	60A
15	STBD CONTROL SUPPLY POSITIVE MAIN AUX FUSE		60A
16	PORT CONTROL SUPPLY POSITIVE MAIN AUX FUSE		60A
17	PORT CONTROL SUPPLY NEGATIVE MAIN AUX FUSE		60A

KEY TO FUSES ON MAIN POWER SWITCHBOARD FUSE PANEL

Principal controls and indications.

1. No. 1 & 2 Main power breaker controls & indication.
2. Port & Stbd. generator breaker controls & indication.
3. Generator voltmeter and associated selector switch.
4. Port & Stbd. generator armature and field current ammeters.
5. Main power busbar voltmeter.
6. No. 1 & 2 main battery voltmeters. No. 1 & 2 main battery charge and discharge ammeters.
7. Port & Stbd. diesel engine tachometers.
8. Port & Stbd. generator telegraphs.

Auxiliary Propulsion

51. The purpose of auxilary propulsion is to enable, ahead propulsion only, to be maintained on the port shaft, with the whole of the main propulsion and main power switchboards dead.

Auxiliary propulsion is obtained on the port forward main motor armature.

The output of No. 2 100 Kw. C.P. motor generator is connected to the armature of the port forward main motor in a ward-leonard arrangment.

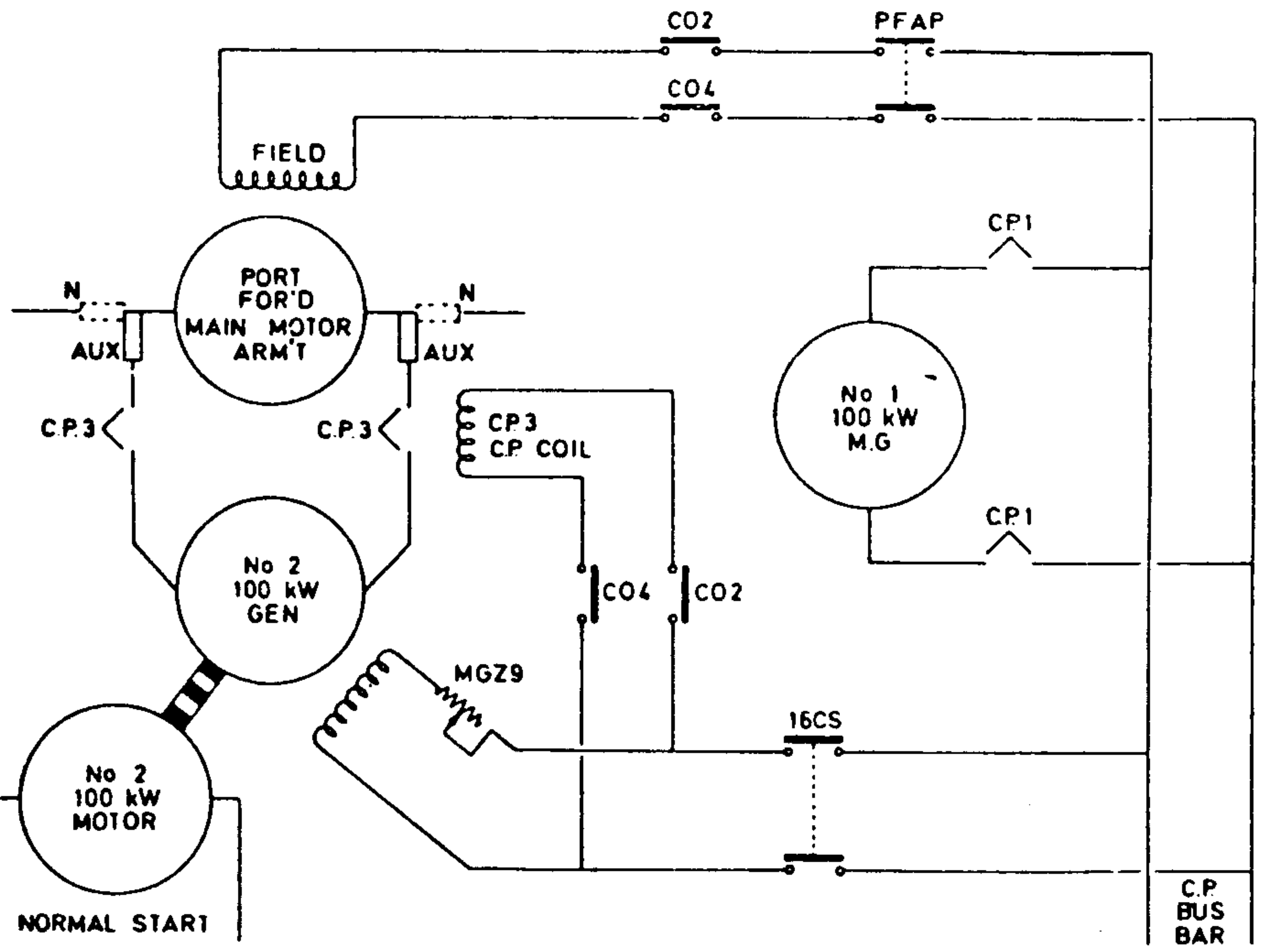
The field of the port main motor is supplied from No. 1. 100Kw. C.P. motor generator. The field is at a fixed value to give the maximum efficiency at slow speeds. No. 1.100Kw. C.P. motor generator is also supplying the C.P. ringmain.

The speed of the main motor is controlled by varing the output voltage of No. 2. 100Kw.motor generator.

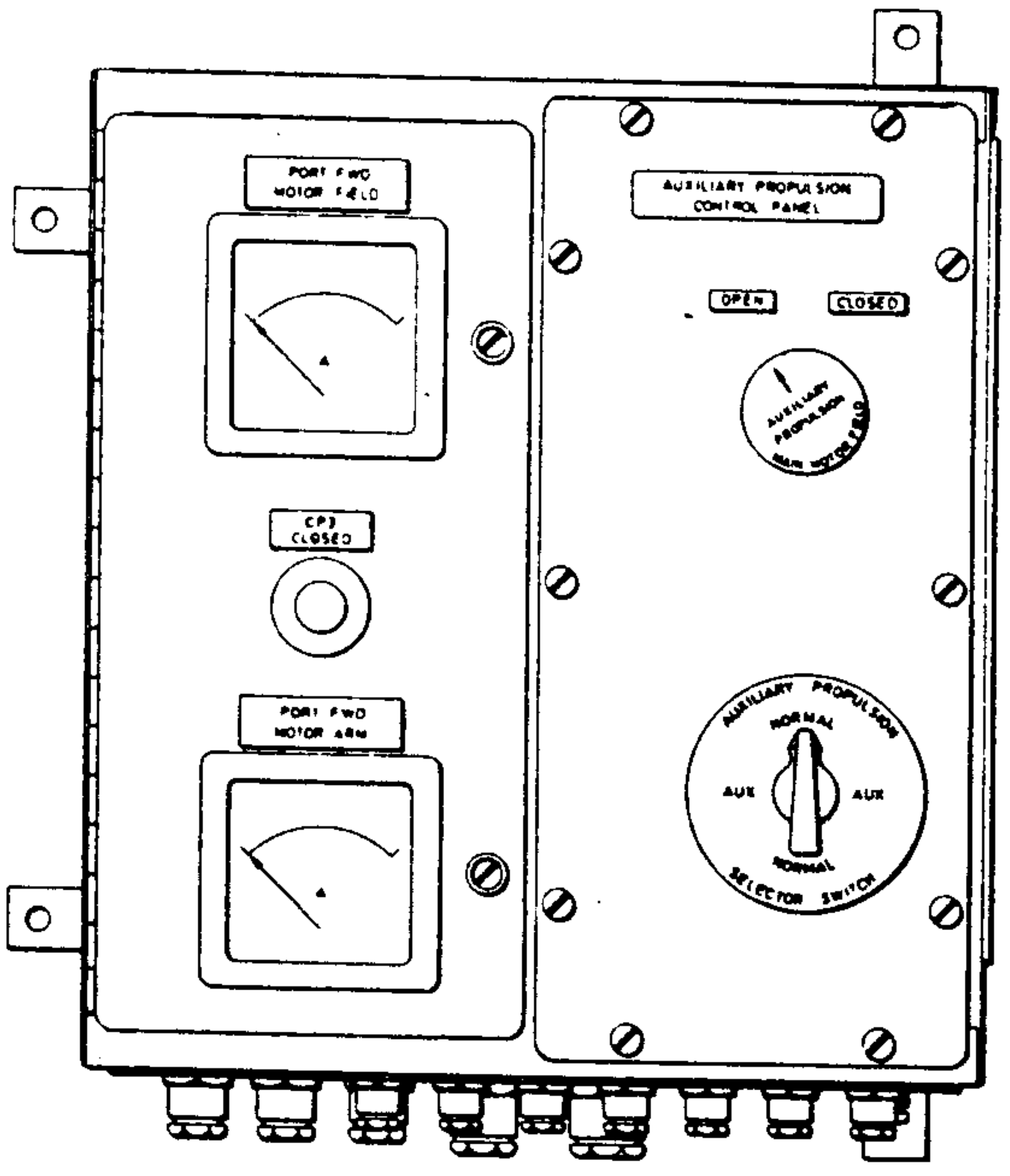
The max. r.p.m. is 90 this limit being the full load of the 100 Kw. motor generator, 444 amps.

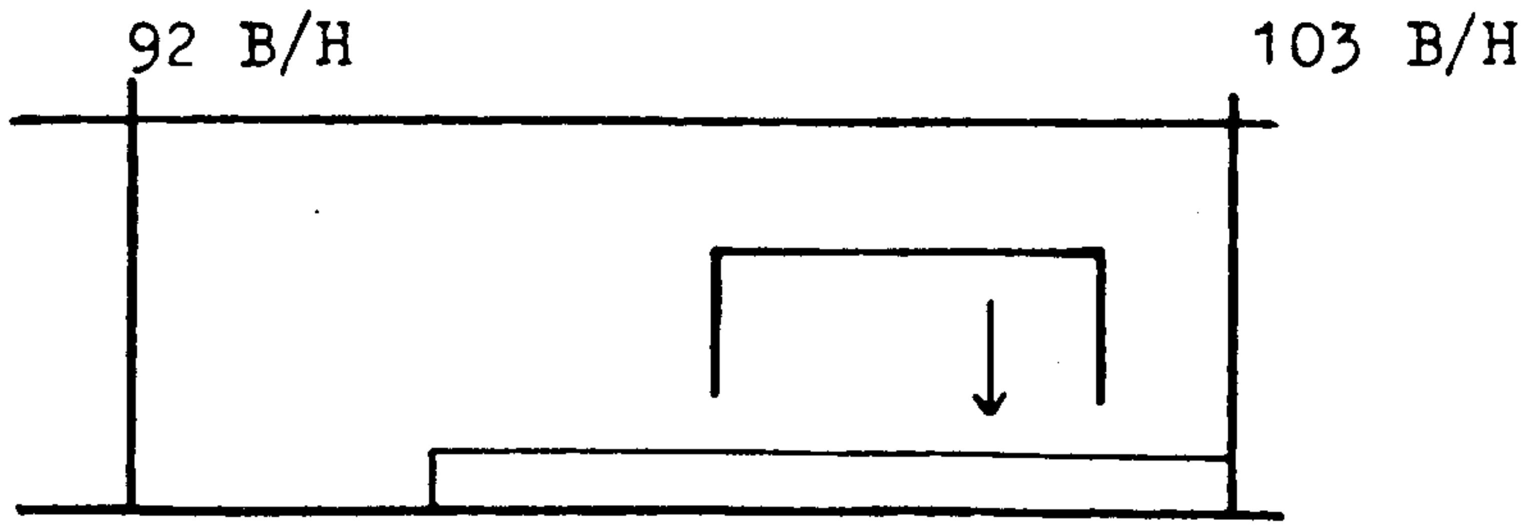
Electrical interlocking is provided to ensure the correct setting up and safe operation.

This routine is found in B.R. 1964(19a) Pt. I chapter 2 parra.89



AUXILIARY DRIVE CIRCUITS

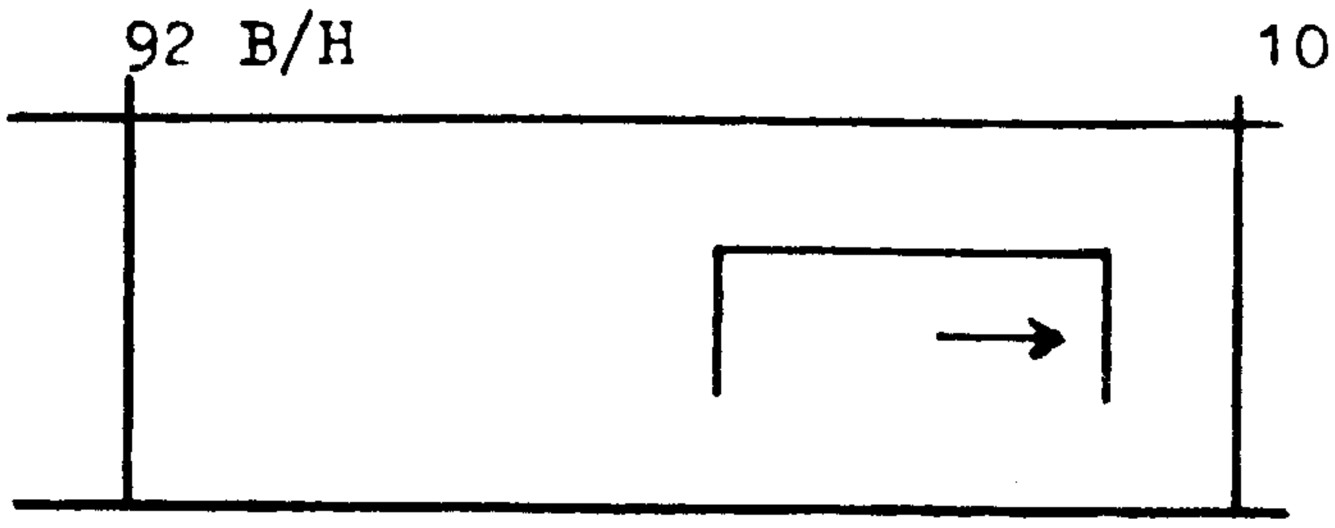


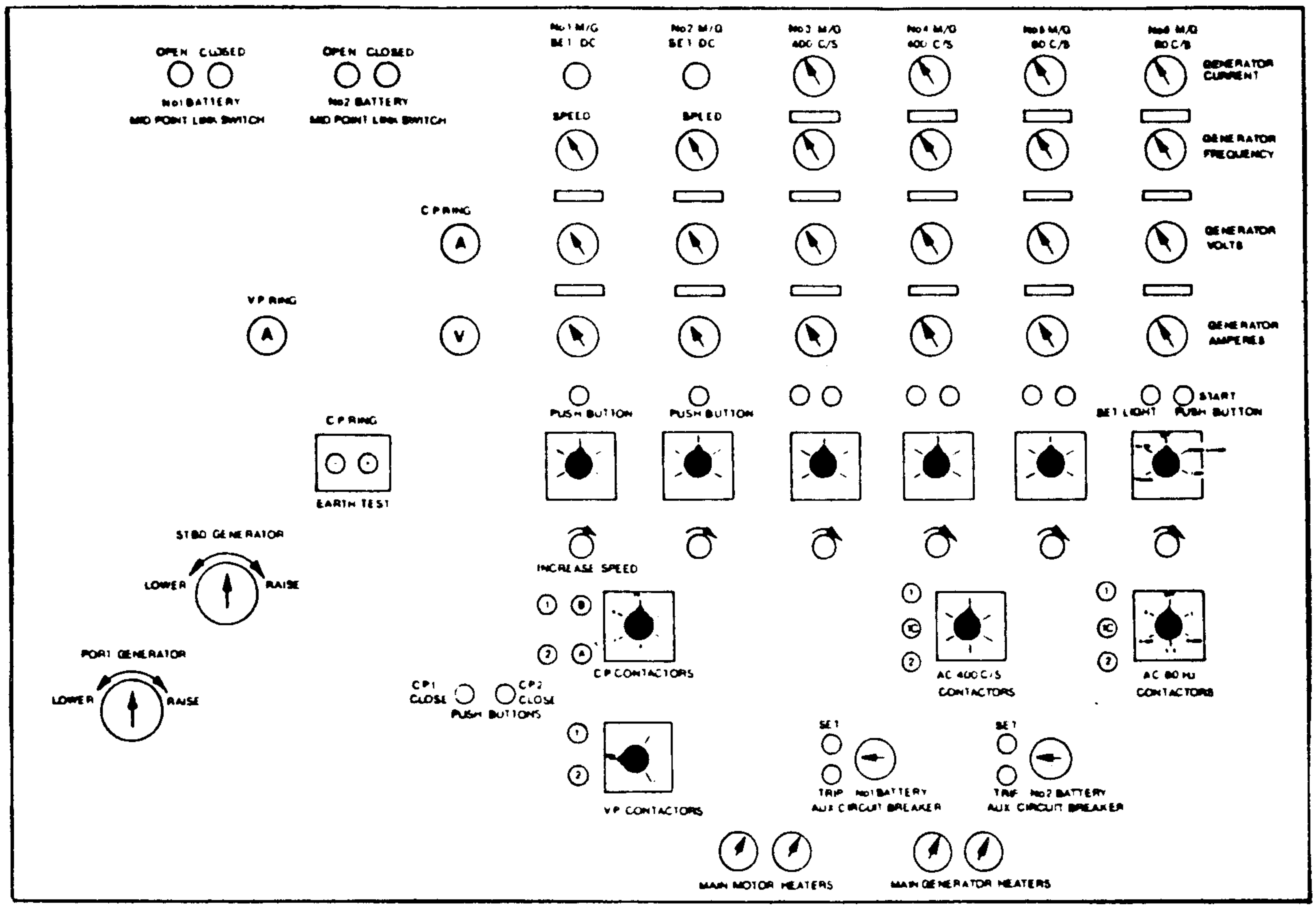


Location of the Auxiliary Propulsion switchboard

Auxiliary Propulsion Switchboard

Auxiliary Power Switchboard





Principal controls and indication

1. Starting, stopping and general control of:
a. No. 1 & 2 220 volt D.C. motor generators.
b. No. 3 & 4 115 volt 60 hertz motor generators.
c. No. 5 & 6 205 volt 400 herts motor generators.

2. No. 1 & 2 auxiliary power breaker controls.

3. No. 1 & 2 V.P. contactor controls.

4. 220 volt D.C. and 115 volt 60 hertz, 205 volt 400 hertz output contactor controls.
5. 220 volt D.C. earth test lamps.

6. Main motor & main generator anti-condensation heater controls.

7. No. 1 & 2 mid point link switch indicating lamps.

8. Port & stbd. main generator field regulators.

220V D.C. (CP) SYSTEM

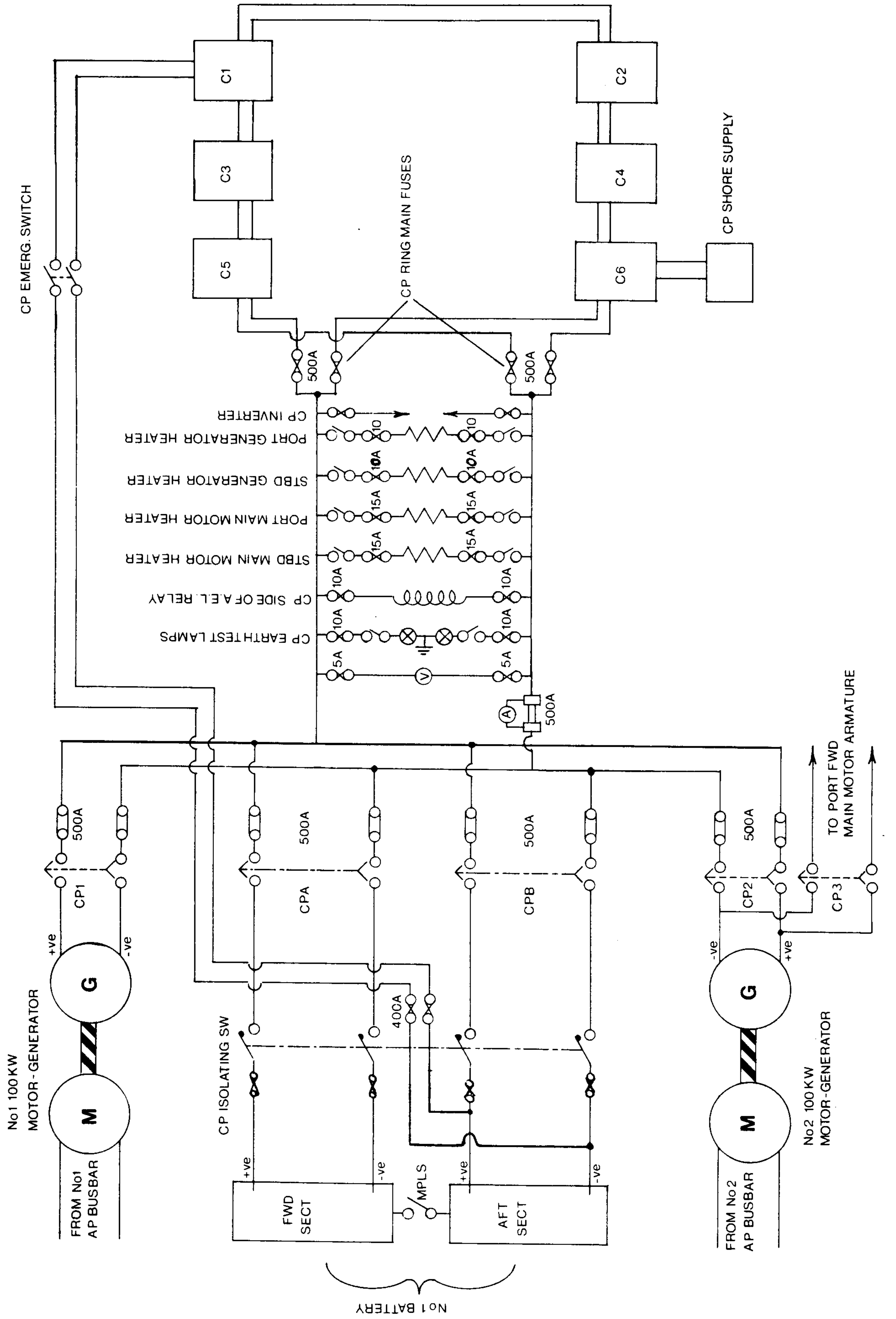


Fig 2-31

52. Starting Sequence for Motor Generating Set

Purpose - the control of motor generator starting. The starting sequence is identical for each set and they are all controlled from the auxiliary power switchboard by five position switches, marked:

OFF - START/HAND - F.R. TEST - TRANSITION - AUTO.

53. Starting a CP Machine

At the auxiliary power switchboard:

a. Rotate the increase speed control fully anti-clockwise.

b. Put the MG set starting switch to START/HAND.

c. Depress the start button and hold in.

d. When the run lamp lights, rotate the INCREASE SPEED control clockwise until the SPEED meter registers 1265 rev/min.

WARNING: If the speed exceeds 1400 rev/min, the "START" button must be released immediately.

e. Release the button.

f. Set the MG set DC starting switch to TEST position.

g. Set the MG set DC starting switch to "TRANSITION" position and note that the reading of the speed meter has decreased, indicating that the AVR amplifiers are functional.

h. Set the MG set switch to the AUTO position.

NOTE: 1. The decrease in speed during the transition period may cause the under/over speed trip to operate. In this case it will be necessary to hold the "START" button in, until the MG set DC switch is to AUTO.

2. The starting of the 60 Hz and 400 Hz M/Gs is identical to that of a CP M/G.
In the Hand/Start position the frequency is adjusted to 60/400 Hz instead of 1265 rpm.

54. Auxiliary Power - CP Ring Main 220 V DC

As can be seen from the CP ring main drawing, the RM consists of six junction panels:

C1 and C2 - Accommodation Space

C3 and C4 - Control Room

C5 and C6 - Generator Room

The ring main can be supplied from six sources:

a. No. 1 100 kW MG set via CP1 contactor.

b. No. 2 100 kW MG set via CP2 contactor.

c. For'd half No. 1 battery via CP "A" contactor.

d. Aft half No. 1 battery via CP "B" contactor.

e. Aft half No. 1 battery via CP emergency switch.

f. Shore supply via shore supply box (C6).

All the equipment associated with CP ring main is sited as follows:

CP1)
CP2)
CPA) contactors bottom rear of the auxiliary power switchboard.
CPB)

Start and run contactors for No. 1 and No. 2 100 kW MG 400 amp fuses for MG sets	auxiliary control frame

The 100 kW MG sets are kept at a constant speed (1265 rpm) and the generator output is kept constant by magnetic amplifiers sited in the motor room passage, port side.

When the machines are switched to AUTO there is no longer any manual control and the switchboard watchkeeper has only to check the meters.

55. Routine for CP Emergency

a. Transfer all load to No. 2 battery.

b. Trip No. 1 main and auxiliary power breakers.

c. Open No. 1 MPLS.

d. Open C1 isolating switch.

e. Make CP emergency switch. This will restore power to C1 junction panel and will supply escape equipment in the fore-end. If it is necessary to supply the rest of the CP ring, the following routine is to be carried out:

(1) Ensure that all CP contactors are open.

(2) Remove CP contactors control fuses or one set of ring main links from each side of the emergency switch at C5 and C6.

(3) Confirm that the fault has been isolated.

(4) Make C1 isolating switch.

56. Supplying CP from CP "A" or "B"

If both CP machines are to be out of action for a considerable length of time, the CP ring main can be supplied from CPA or CPB.

a. Transfer all load to No. 2 battery.

b. Trip No. 1 main and auxiliary power breakers.

c. Open No. 1 MPLS.

d. Make CP battery isolating switch.

e. Select CPA or CPB on CP contactor selector switch.

In order to keep both halves of No. 1 battery at approximately the same state of charge, it will be necessary to change from CPA to CPB at frequent intervals (every 30 minutes).

CP Battery Isolating Switch

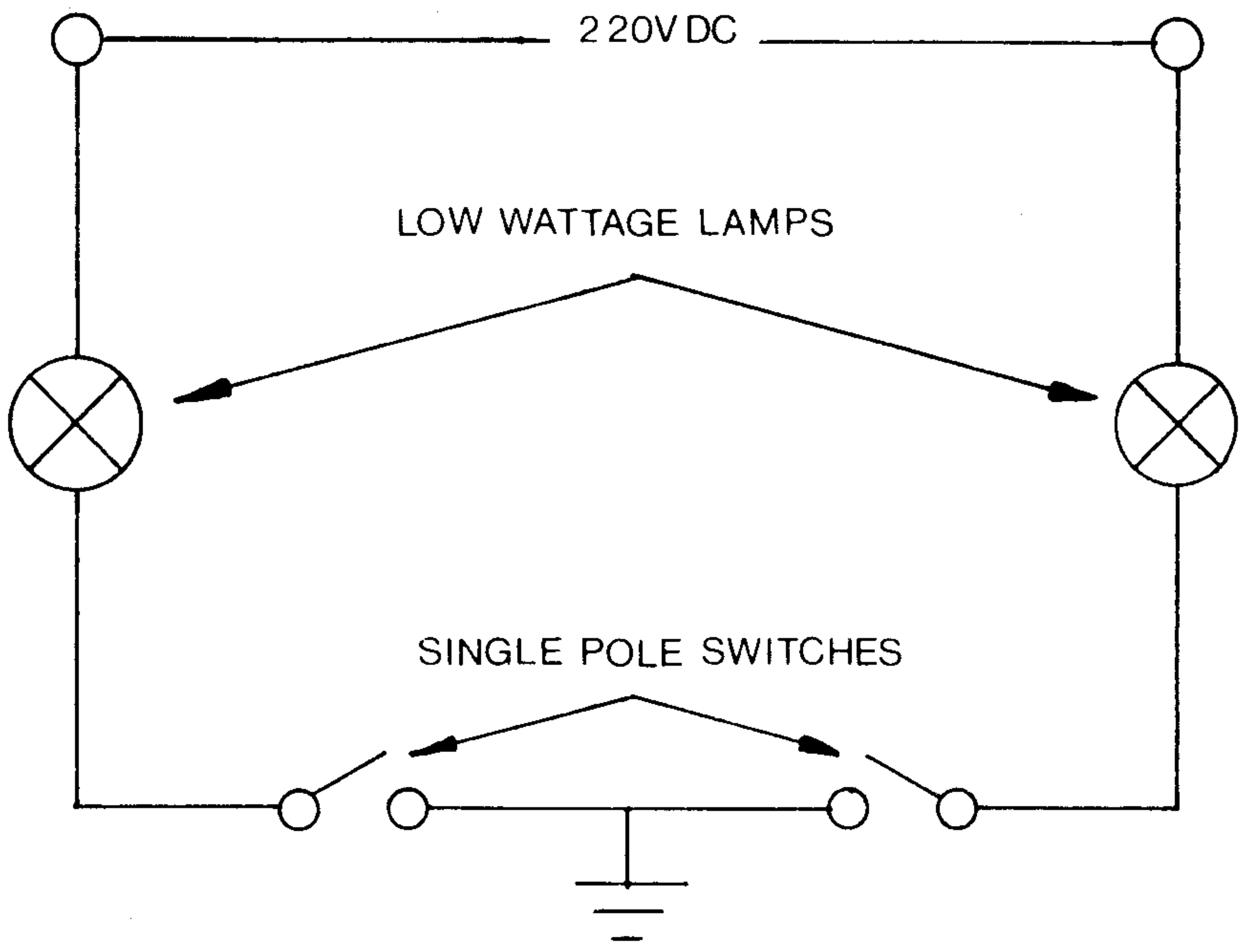
This switch, when open, isolates the CP "A" and CP "B" contactors from their supplies at No. 1 battery switchboard. It is situated in the motor room alongside the master isolating switch.

57. To Connect CP to Shore Supply

a. Open isolating switch C6.
b. Check cables and connect to shore supply box.
c. Have shore supply switched on and check polarity.
d. If c. above is correct, switch CP contactor selector switch to "OFF".
e. Make C6 isolating switch.

The shore supply connection box is sited in the engine room port aft.

CP EARTH TESTING



CP EARTH TESTING

Fig 2-33

The lamps should burn in series at equal brilliancy. If there is a positive earth, the lamp in the positive line will be short circuited and the other lamp will burn brighter. The brilliance of the lamp will be determined by the severity of the earth. It can be seen that the lamp in the negative line indicates a positive earth and vice versa. To ensure that both lines are checked individually, switch on one at a time.

This test is to be carried out at least once per watch.

58. Variable Pressure Ring Main (VP) 374-630 V DC

The VP ring main is supplied from either No. 1 or No. 2 battery, via the auxiliary power breakers and respective VP contactors VP1 and VP2.

VP1 and VP2 are electrically interlocked to prevent both contactors being made at the same time.

There are four ways of supplying the VP ring:

a. From No. 1 battery via APB and VP1.

b. From No. 2 battery via APB and VP2.

c. From No. 2 battery via the VP emergency switch.

d. From shore via the shore supply connection box.

59. VP in Emergency - RANSSO 3372-3375

a. Break the charge.

b. Attempt to supply the VP ring main via the other contactor.

c. Run up all other AC machines, supply each half of the AC ring mains from their own machines.

d. WEEO to close up in the control room and take charge of restoring power. He will:

  (1) Ascertain that the cause of the VP failure allows VP to be supplied in emergency.

  (2) Check that the fault is not on V2 junction panel (if so V2 must be isolated).

  (3) Ensure that the hydraulic pumps are switched off at the panel and that the starters are not ON in local hand control.

e. He will order the following actions:

  (1) Switch off all VP machinery.

  (2) Hang DO NOT OPERATE tallies on all VP machinery (report to CR on completion).

  (3) Open V2 junction panel isolating switch.

  (4) Make VP emergency switch.

  (5) Remove tallies from machinery fed from V2.

f. Inform the Captain and OOW when machinery fed from V2 may be used.

g. Isolate any damage to the VP ring.

h. Ensure that both VP contactor indicating lights show green and sight the contactors open.

i. Remove VP contactor control fuses.

j. Remove X and Y links.

k. Make V2 junction panel isolating switch.

l. Inform the Captain and OOW of the state of the VP ring and which VP equipments may now be used, and remove DO NOT OPERATE tallies from appropriate machines.

60. Routine for Supplying VP from Shore Supply

a. Ensure that all supplies from V1 are OFF.

b. Open V1 isolating switch.

c. Ensure that VP SS fuses have been removed (V1).

d. Connect cables to SS connection box and inspect cables.

e. Carry out insulation, continuity and non-contact tests of cables.

f. Switch on and check polarity.

g. If polarity is correct, ensure VP contactors are open and remove contactor control fuses.

h. Switch off SS.

i. Replace VP SS fuses.

j. Switch on SS.

k. Make V1 isolating switch.

NOTE: If required, VP SS may be used to supply the auxiliary power bus-bars.

61. Drill for Working on Machinery Fed from VP

a. Locate VP panel supplying machine.

b. Stop all machines fed from this panel, hang warning boards from starter.

c. Break VP supply switch at panel.

d. Remove VP fuses for machine being serviced.

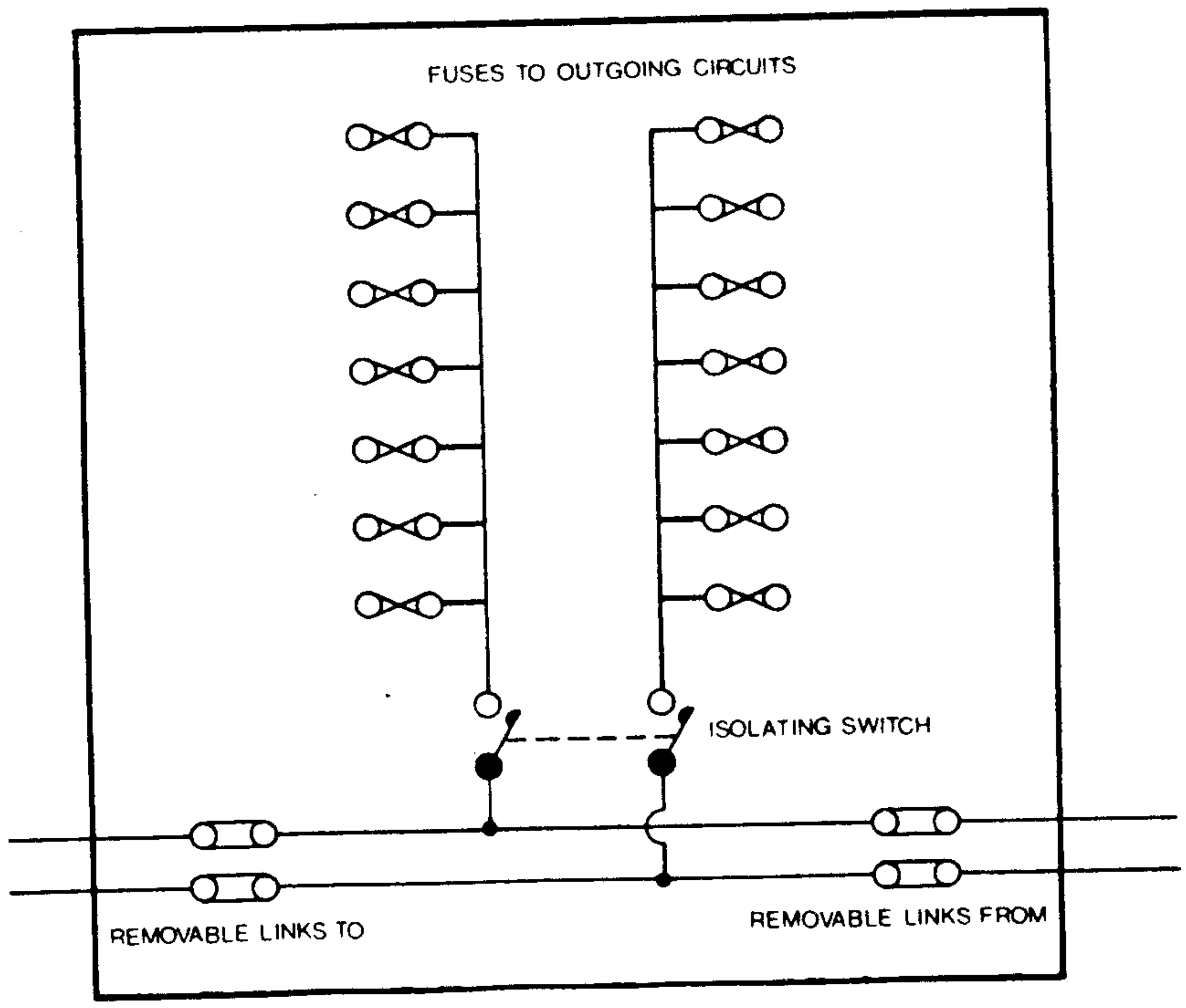
e. Make VP supply switch.

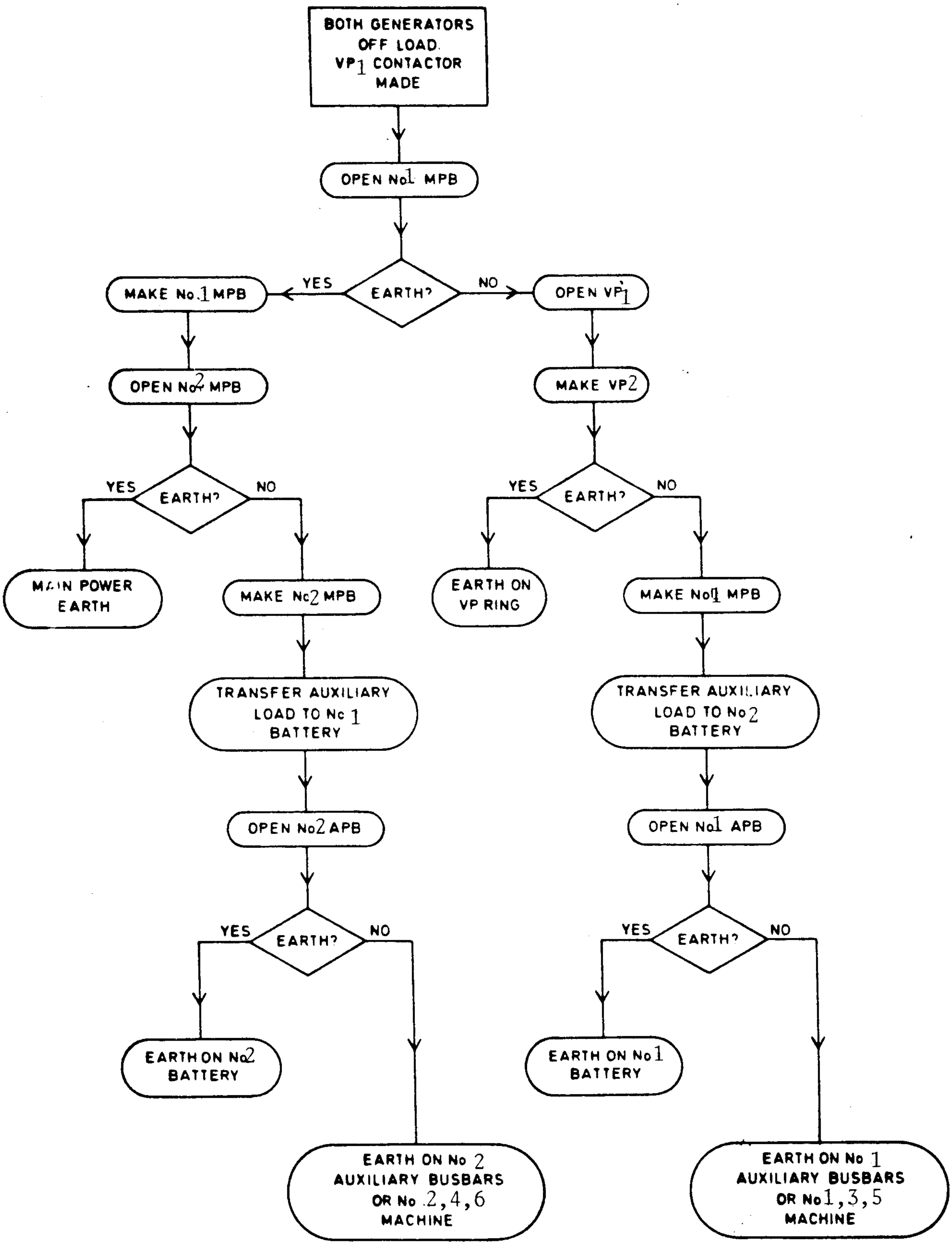
f. Remove warning boards and re-start machines which have been stopped.

g. To replace fuses, repeat the above drill.

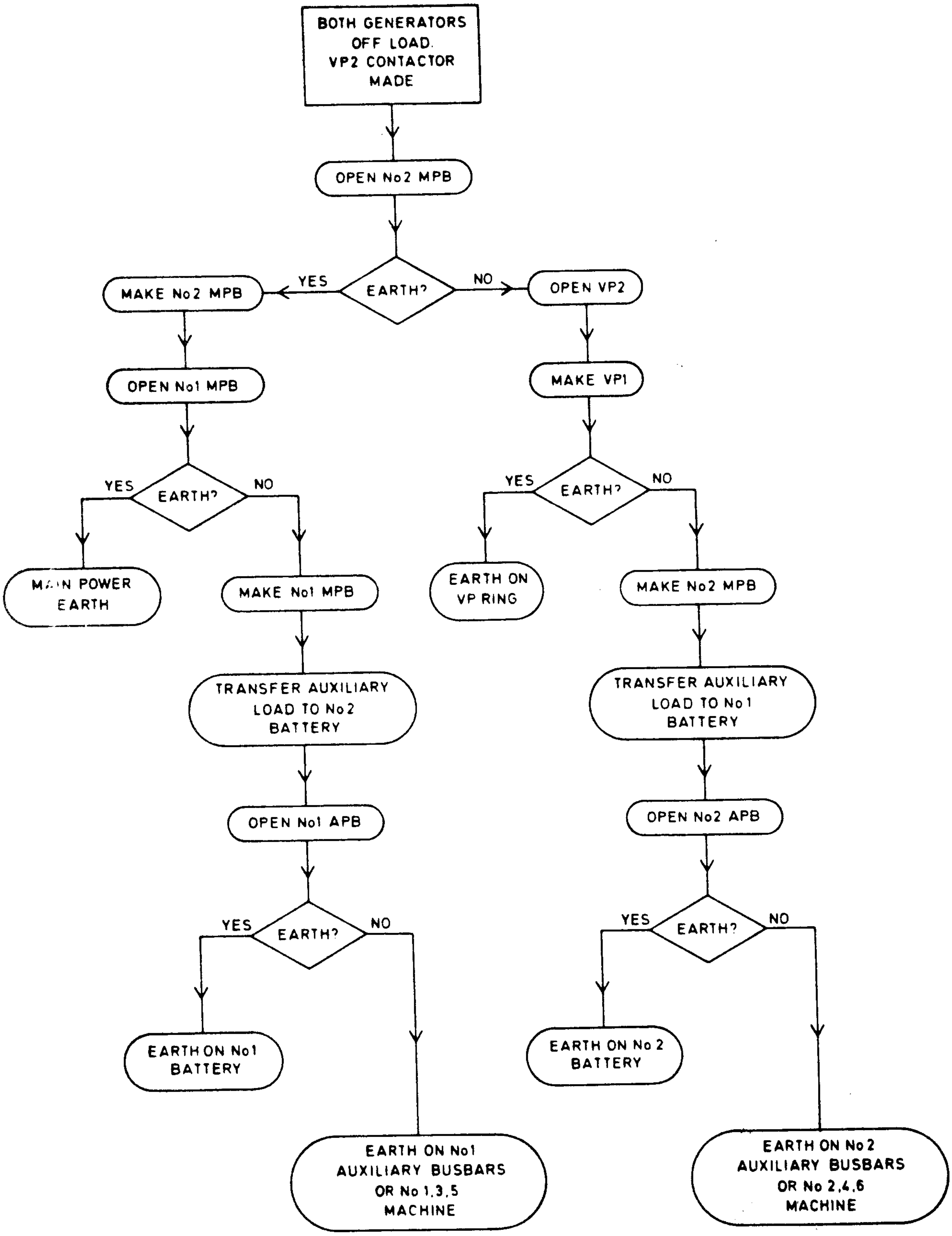
NOTE: Two electrical ratings must be present during the above operation.

ELECTRICAL JUNCTION PANEL





VP earth finding guide



VP earth finding guide

62. Precharge checks

The following checks are to be carried out PRIOR to commencing a battery charge.

a. Dip both batteries
b. Shut down hydrogen clearance fans
c. Open up and run battery ventilation
d. Check ships ventilation running correctly
e. Check both battery sumps
f. Run up battery agitation
g. Check battery cooling running correctly
h. Check cathelco switched on
i. If shore charging i) check battery ventilation trunking pointing downwind
    ii) check that at least one hatch fwd. other than the tower is open
    iii) check after services running through 4MBT

63. Routine for charging 440V through Port Generator Breaker

a. Establish communications with the powerhouse
b. Change position of shore charge links from SHIP to SHORE position
c. Inspect shore charge cables and connect
d. Check cables for insulation and continuity with 1000V Megger
e. Sign powerhouse access permit and return it to the powerhouse
f. Switch ON. Test for polarity
g. Switch OFF.
h. Carry out precharge checks
i. When ready to charge inform powerhouse to switch ON and raise voltage until it is 5 volts above busbar volts and then set the generator voltmeter selector switch to PORT and then MAKE the port generator breaker. The charging rate can then be increased to the maximum available.

NOTE : The shore charge links are situated at the bottom of the port generator breaker and access to them is from the lower motor room. These links are similar to the * and ** links in the battery switchboards.

64. Routine for Shore Charging from 220 V Source

a. Establish communications with shore source.

b. Transfer load to battery not being charged.

c. Open main and auxiliary power breakers and MPLS of battery to be charged.

d. Remove * and ** links.

e. Connect SC cables to * and ** link terminals and visually inspect cables.

f. Test for continuity, non-contacts and insulation.

g. Have source make supply and check polarity. Then switch "OFF".

h. Place * and ** links in SC position.

i. Run battery ventilation, etc.

j. Tell source "READY FOR CHARGE" and ask if you can "MAKE THE AUXILIARY POWER BREAKER" (by hand).

k. Inform source when correct amount of charge is on, when to make reduction and when to break.

l. On completion, inform source "READY TO BREAK" and open auxiliary power breaker.

m. When power is off, remove cables and replace * and ** links in normal running position.

n. Make up MPLS, main and auxiliary power breakers. Transfer load from other battery and repeat the process.

65. Routine for Shore Charging From 440 V Source

a. Establish communications with shore source.

b. Transfer load to battery not being charged.

c. Open main and auxiliary power breakers of battery to be charged.

d. Remove * and ** links.

e. Connect SC cables to the ** terminals and visually inspect leads.

f. Check leads for continuity, non-contact and insulation.

g. Have power put on and check polarity.

h. Have power taken off.

i. Place ** links in ** shore charge position.

j. Run battery ventilation, etc.

k. Tell source "READY TO PUT ON CHARGE" and ask "IF YOU CAN MAKE AUXILIARY POWER BREAKER".

l. Inform source when correct amount of charge is on, when to make reductions and when to break.

m. On completion, inform source "READY TO BREAK" and open auxiliary power breaker.

n. When power is off, remove leads, replace * and ** links in normal running position.

o. Make main and auxiliary power breakers, transfer load from other battery and repeat the process.

66. AC Supplies 115 V 60 Hz System

Two in number 15 KVA. 60 Hz. Three phase motor generator sets supply a ring main via individual contactors AC5 and AC6, whilst another contactor AC8 is used to interconnect the ring port and starboard, if in the normal line up i.e. using only one machine. An interlocking system prevents the two machines being paralleled.

Two main distribution panels are situated in the control room. In an emergency, the panels can be cross-connected by means of the rotary switch on the side of the panel, thus supplying both panels from one machine but bypassing the interconnector. This should only be necessary if the interconnector is defective.

Both machines are magnetic amplified controlled for voltage and frequency.

67. 205 V 400 Hz Three Phase Four Wire System

Two 15 KVA motor generator sets are fitted feeding a ring via Star/Delta transformers supplying 120 V 400 Hz. Three phase, four wire in a similar set up to that of the 60 Hz system.

68. AC Summary

The only AC supply not transformed is 115V 60Hz 3Ø. Amenities sockets have their own internal transformers.

230 V 60 Hz supplies are obtained by three in number step up transformers situated in the motor room.

AC interconnectors are fed from the live side of the VP ring main, as this is the most stable supply. In the event of a VP failure however, and the system in the normal line up, the interconnector would open, causing half the AC supplies to be de-energised.

Control switches for the 60 Hz and 400 Hz contactors and associated indicating lights are fitted on the auxiliary power switchboard.

Starting controls for the AC motor generator sets are also on the auxiliary power switchboard.

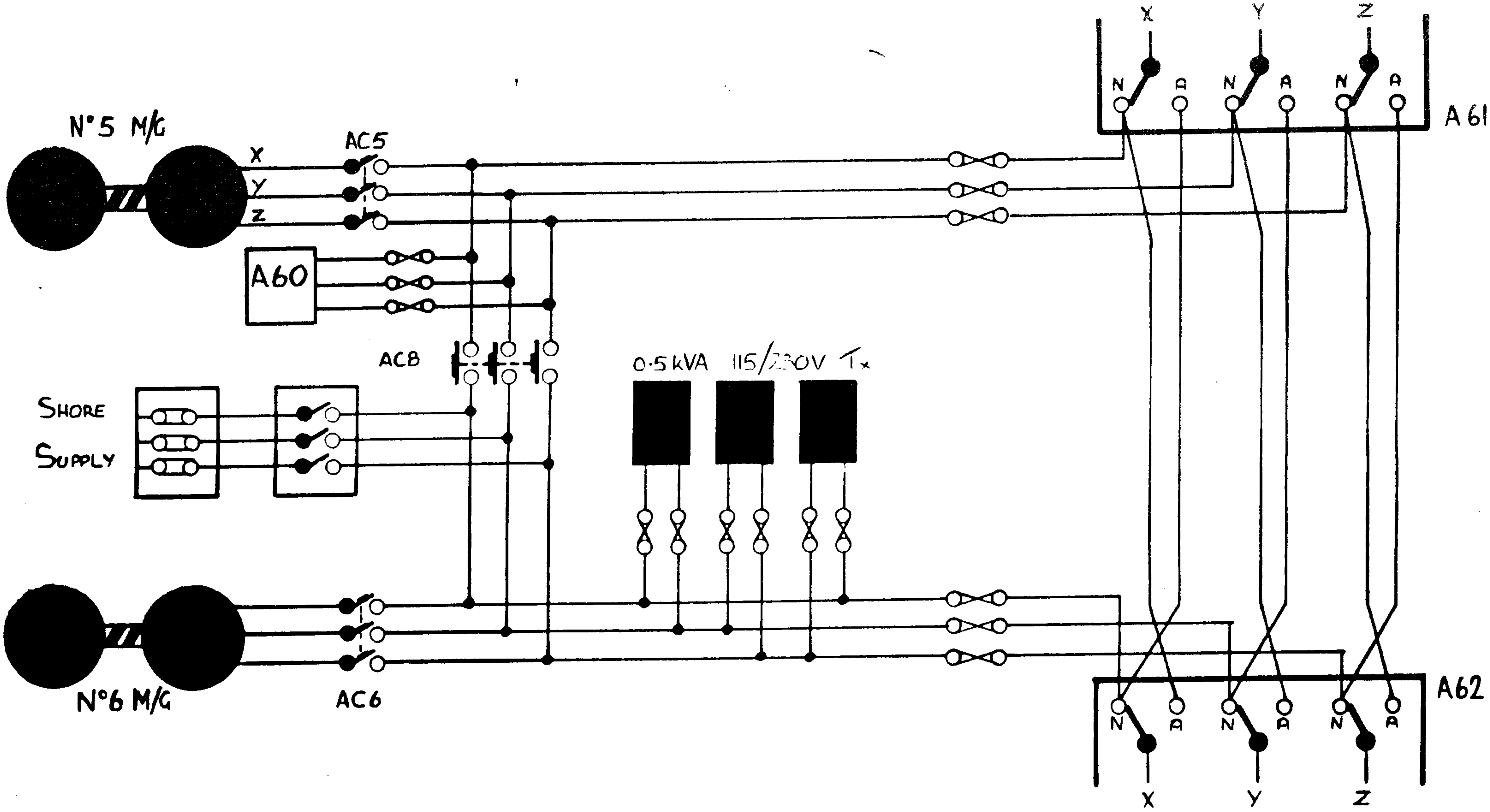
AC output contactors are in the auxiliary control frame: as are the MG start and run contactors and the AC interconnectors.

Some examples of AC equipment are:-

a) 115V 60Hz - fluorescent lighting, mess fridges, H2 fans, axial flow fans.

b) 205V 400Hz - gyros, fire control, sonar .

NOTE Otama and Orion have had a 60Hz machine replaced with a larger 25kVA machine (No 6 machine).



115V 60Hz 3Ø SYSTEM

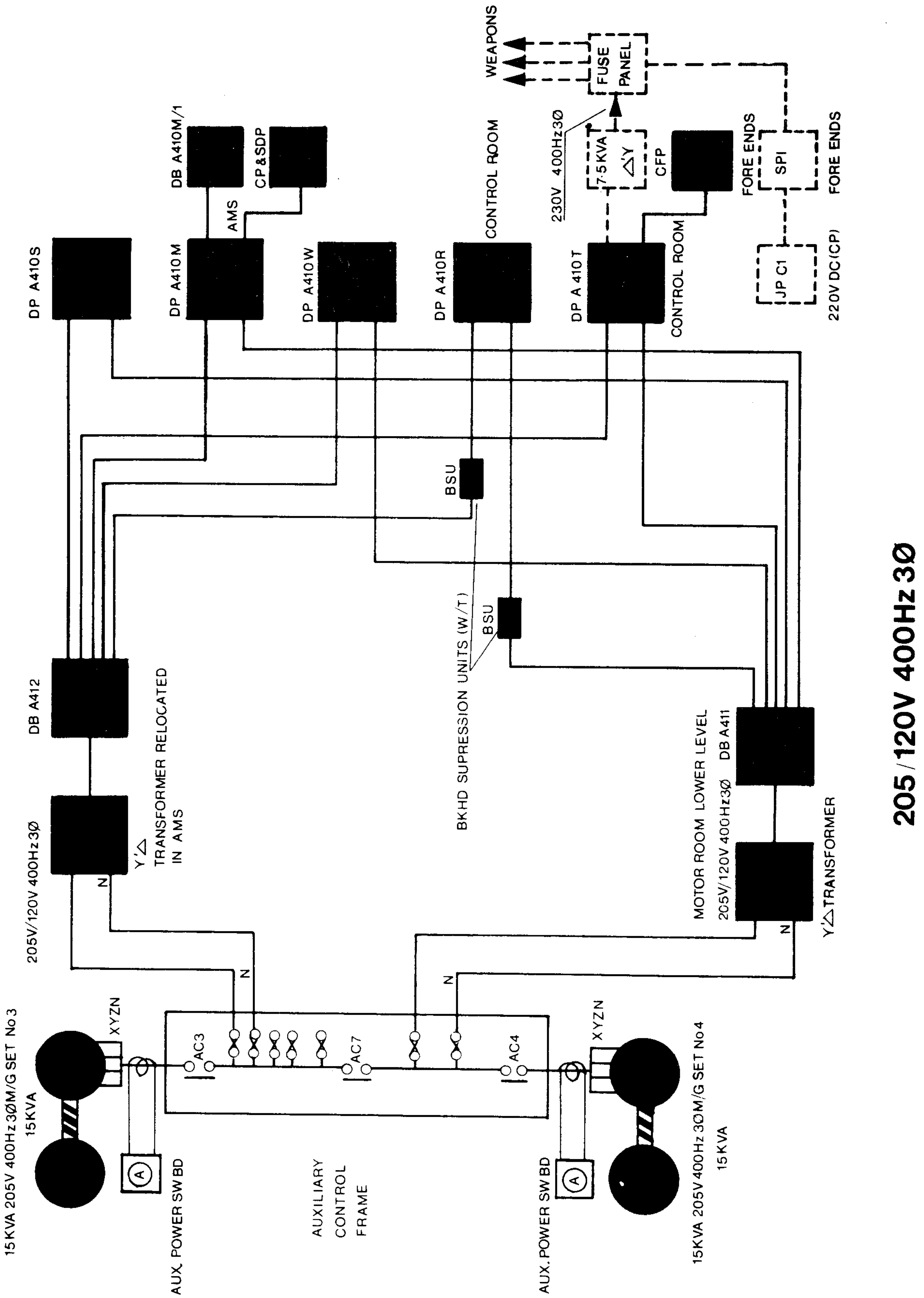
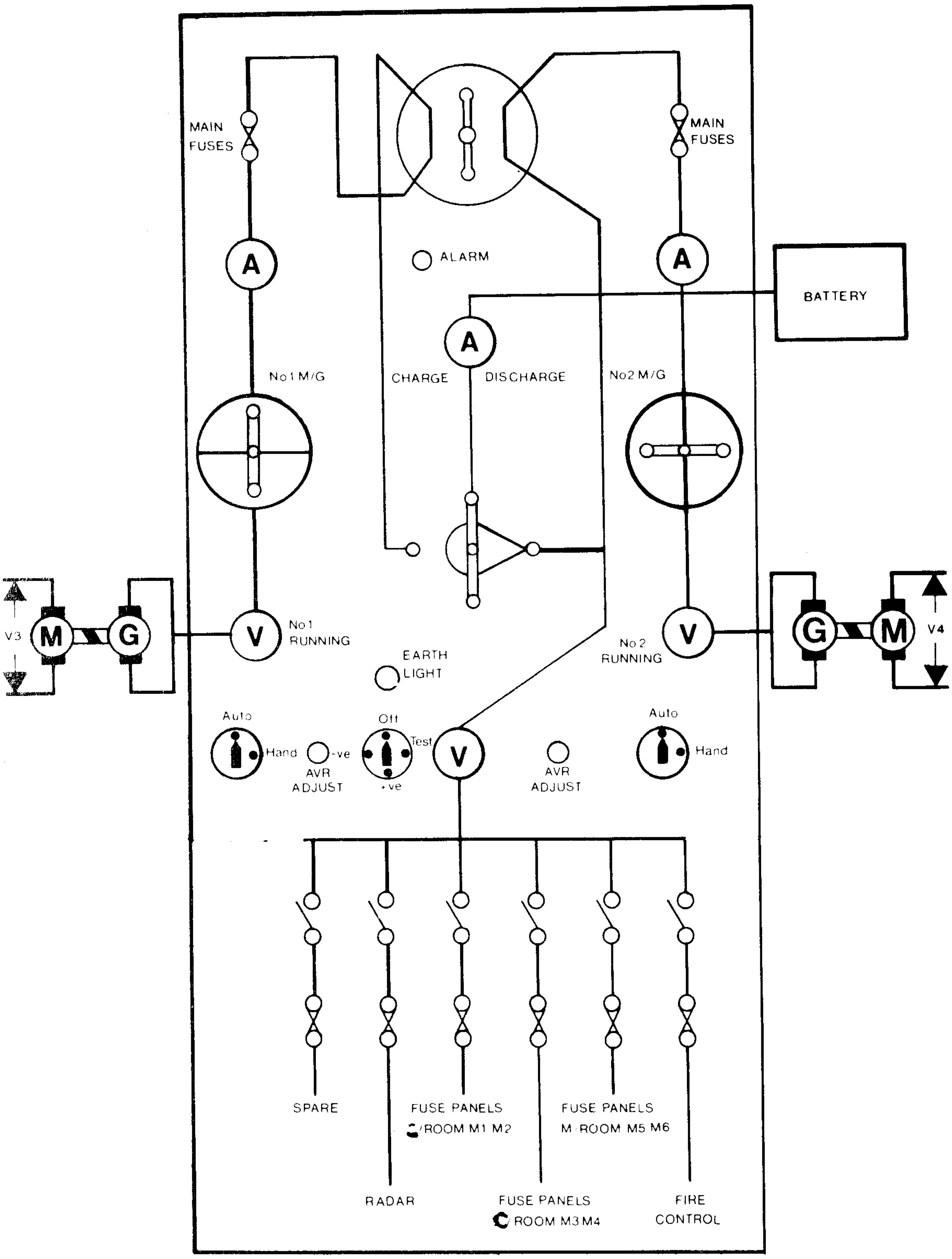

205/120V 400Hz 3Ø
WEAPONS
FUSE PANEL
230V 400Hz3Ø
7.5KVA
△Y
CFP
FORE ENDS
SPI
FORE ENDS
JP C1
220V DC(CP)
DB A410M/1
CP&SDP
AMS
CONTROL ROOM
DP A410S
DP A410M
DP A410W
DP A410R
DP A410T
CONTROL ROOM
BSU
BSU
BKHD SUPRESSION UNITS (W/T)
DB A412
TRANSFORMER RELOCATED IN AMS
Y'△
205V/120V 400Hz3Ø
N
MOTOR ROOM LOWER LEVEL DB A411
205V/120V 400Hz3Ø
Y'△ TRANSFORMER
N
N
N
XYZN
XYZN
AC3
AC7
AC4
15KVA 205V 400Hz 3ØM/G SET No3
15KVA
AUX. POWER SWBD
A
AUXILIARY CONTROL FRAME
AUX. POWER SWBD
A
15KVA 205V 400Hz 3ØM/G SET No4
15KVA

Fig 2-36



OBERON CLASS L.P. SWITCHBOARD

Fig 2-37

69. Low Power System

Two in number 4 kW 24 V DC MG sets are fitted in P and O class submarines, backed up by a 350 amp/hr battery.

The low power battery is fitted in the motor room lower level forward of the 100 kW generators. The low power control and distribution panel is fitted port side forward of the motor room.

Six in number low power fuse panels are fitted numbers 1-4 in the control room, numbers 5-6 in the motor room.

Hand starters for the LP MG are fitted in the motor room.

Normal running procedure - one LP MG running with the LP battery floating.

70. Operation of LP

In the event of a failure of the lower power generator, the LP battery will take over and supply the essential services, 24 V DC. The battery must remain floating on the bus-bars at all times when the submarine is at sea, therefore it is essential that the LP battery is in a fully charged state before going to sea. A failure of the running MG will have no effect on 24 V supplies, as the battery will take over and supply all the 24 V services.

The change-over switch (HAND-AUTO) in the circuit, allows the generators to be controlled by a hand regulator or when in AUTO, by a carbon pile AVR.

The HAND position is used with the generator charging the battery. A hand regulator is switched into the generator field circuit which controls the output 18-33 V.

The AUTO position is used with the generator feeding the bus-bar. Here the exciter generator feeds the generator field through a carbon pile regulator with its central coil in the machine's output. A trimmer is provided in this circuit to set the controlled output voltage.

If the battery takes over due to a fault on the MG, a transistorised alarm circuit operates a warning light to indicate that the battery has taken over.

71. Routine Charging

Routine charges must be carried out in accordance with the Planned Maintenance Schedule and a proper Fair Log kept of all work carried out on the battery.

In the event of a total 24V failure the only services remaining will be:-

a) VP (except ACU's)

b) propulsion

c) lighting by AEL's only

d) hydraulic pumps in local hand control.

e) communications by sound powered phone andSHINWA

CATHELCO
ELECTROLYTIC SYSTEM
for the
CONTROL OF CORROSION AND MARINE GROWTH.

72. The CATHELCO system is a patented electrolytic method developed specifically for:-

a) The control of marine growth (MG) in sea water systems
b) The reduction of corrosion of metal in contact with water.

The CATHELCO system uses dual purpose, bi-metal anodes which controls both marine growth and corrosion - the former being virtually eliminated, while the latter will be reduced by anything up to 80% of that normally to be expected.

The first of these objectives is achieved by the process of electrolysis which forms a substance in the sea water which is either toxic, or so distasteful to any of the minute organisms entering that they are discouraged from adhering to some quite spot in the system where they can grow and start breeding. They are instead, carried straight through the system and discharged back to sea.

The second objective is achieved by the other half of the bi-metal anode, which precipitates an alkali that is carried along the pipes of the system and will, in due course, form a protective coating on the various surfaces along which the water passes. This coating, whitish in colour, takes several months to be formed throughout the system, the time taken being called the'conditioning'period

75. There are four(4) bi-metal, dual purpose anodes, each housed in an existing SPIRAX strainer casing. Each anode consists of two sections divided laterally, insulated from one another and known as the MARINE GROWTH(MG) and TRAP(TC) anodes. The former as its name implies is for the control of marine growth, while the latter is for the control of corrosion. The sections are of such a size that at normal current settings they will be due for renewal at about the same time.

76. Before putting the CATHELCO system into serviceit is most important to ensure that the pipe lines are clear of fouling. If this is not the case, any shellfish present will be dislodged as the treatment takes effect, with the consequent risk of blockages occuring.

CATHELCO

"OBERON" CLASS SUBMARINES

0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

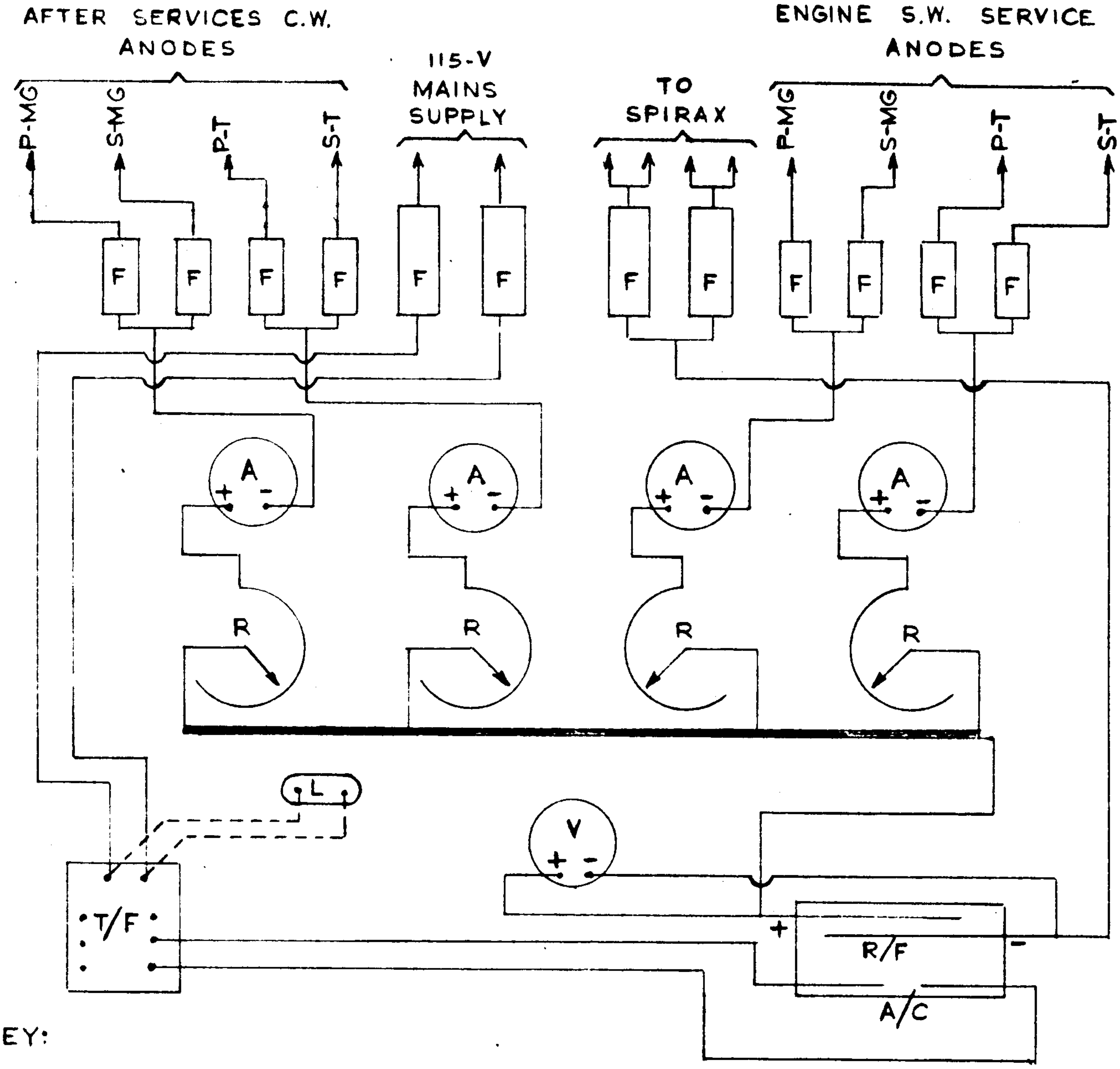
DETAILS OF COMPONENTS

79.

TRANSFORMER	V.S.S. Transformers Ltd. Sheffield 225 VA. 115V,1Ø input 15V, 15A. output. Tapped- 15,12,10,8,4,0 volts
RECTIFIER	Westinghouse B & S Co. Chippenham Wiltshire Air cooled selenium. Cat No. 2AC 163 15.6V - 14.4A tropical
METERS	Walsall Electrical Co. Ltd., Walsall Staffs Polarised moving iron, type BFP Ammeters scaled 0/4A; Voltmeter scaled 0/5V
RESISTORS	British Electric Resistance Co. Enfield, Middlesex. Bercostat, type L100 - 5.75A ; 3 ohms.
FUSE HOLDERS	Ed. Wilcox Ltd., Manchester. "SLYDLOK" - 5A. Type X.5342, 15A. Type H.1522
PILOT LIGHT	Ed. Bulgin Ltd., Barking, Essex. Neon, with built in resistance, type D.715T/115V

ANODES	Electrolytic Marine Corrosion Services Ltd Canada. MARINODE, dual purpose - nominal 3½" dia. x 8½" long.

-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-



KEY:

A - AMMETER
F - FUSE
L - PILOT LIGHT
MG- MARINE GROWTH

P - PORT
R - RESISTOR
R/F - RECTIFIER

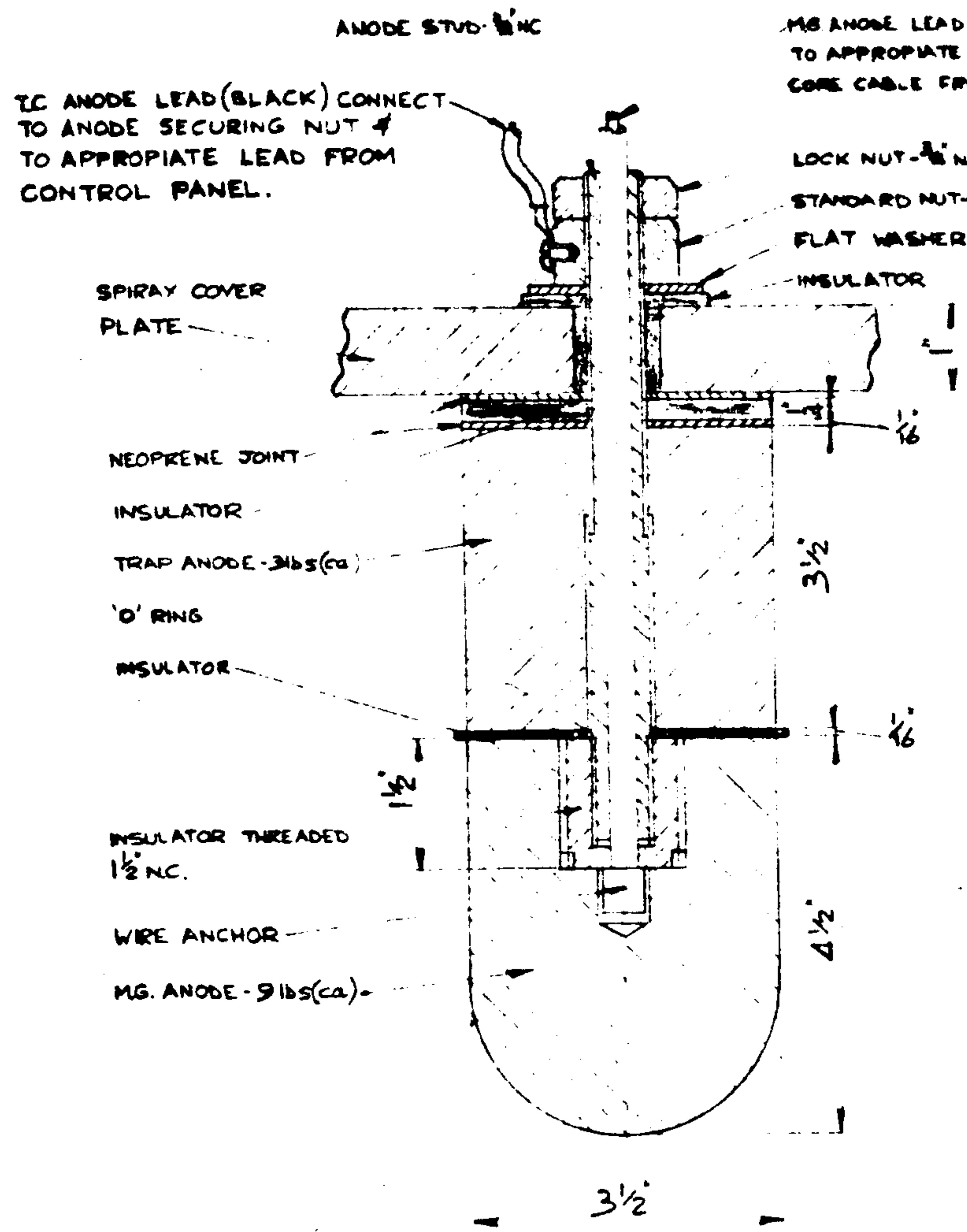
S - STARBOARD
T/F - TRANSFORMER
T - TRAP
V - VOLTMETER

CATHELCO SYSTEM
OBERON CLASS SUBMARINES
CONTROL PANEL WIRING DIAGRAM

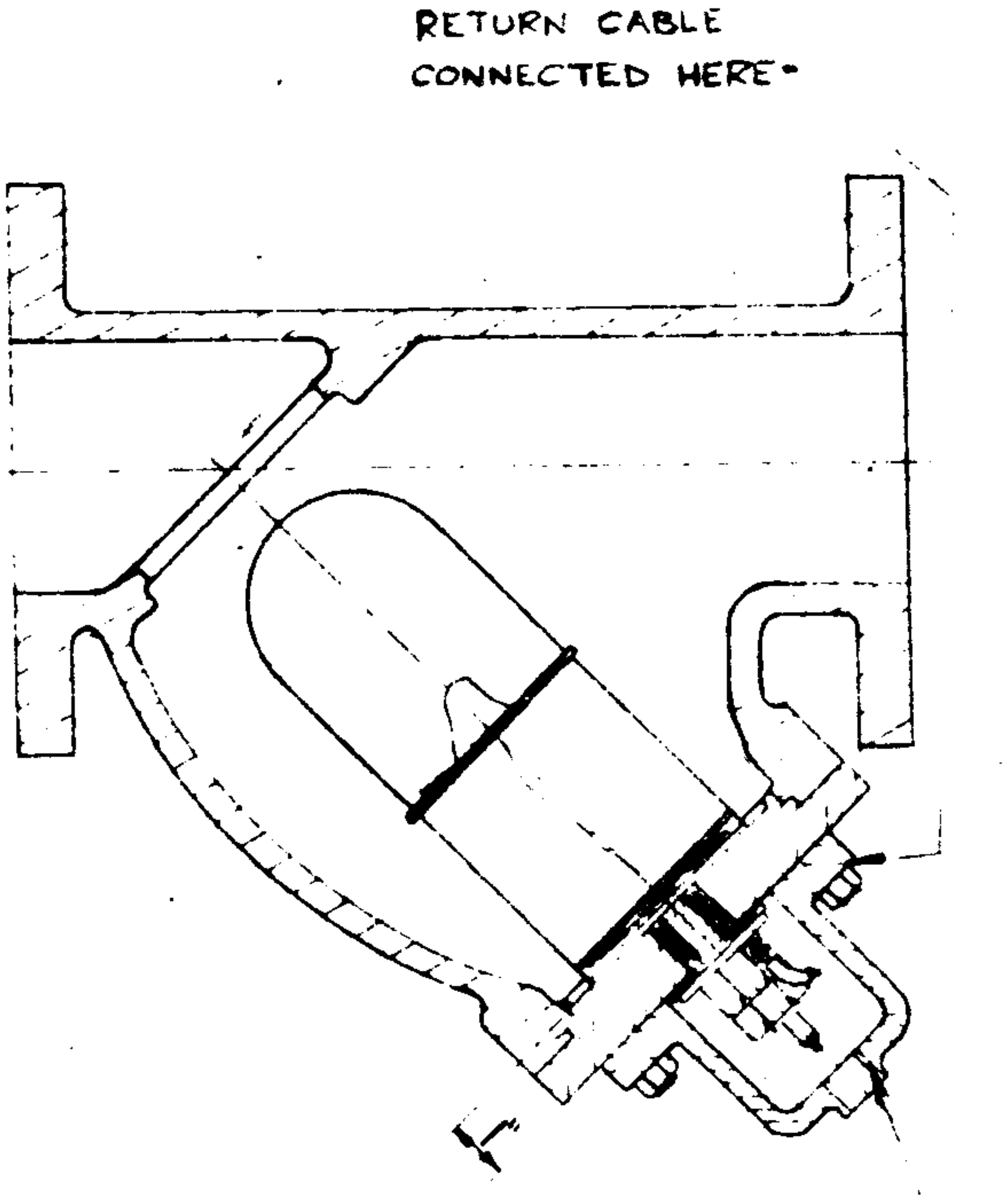
ROYAL AUSTRALIAN
NAVY
AUSTRALIA HOUSE
STRAND
LONDON W.C.2.

CATHODIC AND ELECTROLYTIC
ENGINEERS CO. LTD.
81, SALTERGATE.
CHESTERFIELD. DERBYSHIRE.

DATE - 20/10/69
DRN. BY -
SCALE -
DRG. No. - O'S/M/1


ANODE STUD-¾"NC
MG ANODE LEAD (RED) CONNECT TO APPROPIATE LEAD OF TWIN CORE CABLE FROM CONTROL PANEL.
T.C. ANODE LEAD (BLACK) CONNECT TO ANODE SECURING NUT & TO APPROPIATE LEAD FROM CONTROL PANEL.
LOCK NUT-¾"N.C.
STANDARD NUT-¾"N.C.
FLAT WASHER
INSULATOR
SPIRAY COVER PLATE
1/16"
NEOPRENE JOINT
INSULATOR
TRAP ANODE-3lbs(ca)
3½"
'O' RING
INSULATOR
1/16"
1½"
INSULATOR THREADED 1½"N.C.
WIRE ANCHOR
4½"
M.G. ANODE-9lbs(ca)
3½"

SECTION OF DUAL PURPOSE COMPOSITE ANODE.



VIEW SHOWING COMPOSITE ANODE MOUNTED IN SPIRAX STRAINER CASING.

½" N.P.T. W.T. GLAND TO TAKE TWIN CORE CABLE FOR M.G. & TRAP SECTIONS.

CATHELCO SYSTEM

OBERON CLASS SUBMARINES

ANODE ASSEMBLY & METHOD OF MOUNTING IN SPIRAX CASING.

ROYAL AUSTRALIAN NAVY. AUSTRALIA HOUSE STRAND LONDON W.C.2.	CATHODIC AND ELECTROLYTIC ENGINEERS CO. LTD. 81, SALTERGATE. CHESTERFIELD. DERBYSHIRE.	DATE - 21/10/69 DRN. BY - ENDESIGN SCALE - DRG. No. OS/M/3

SECTION III

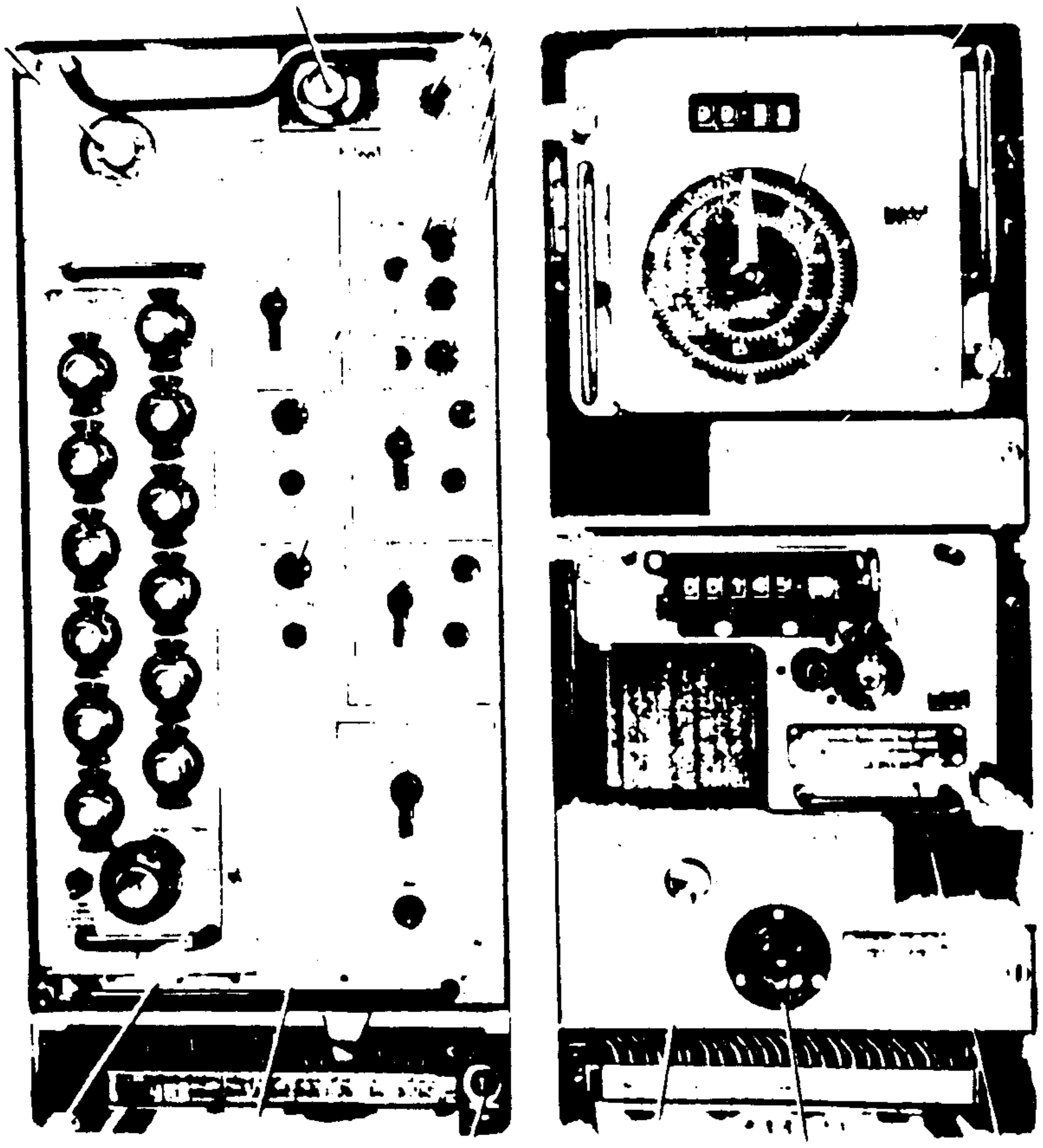
NAV-AIDS AND INTERNAL COMMS

CONTENTS	PAGE
Standard E.M. Log	115
Transistorised E.M. Log	119
Mk 23 Gyro	121
AN/WSN-2	122
1006 Radar	125
Internal comms.	129
Duty statement for the DLSET	139
List of electrical B.R's	140

STANDARD

ELECTRO-MAGNETIC

LOG



STANDARD E.M. LOG.

QUICK REFERENCE DATA.

POWER REQUIREMENTS................................115v 60Hz.
24v DC.

LOG ACCURACY.................................., ±0.1Kts.

HANDBOOK...................... BR. 268(3b) OPERATION AND MAINTENANCE.

OPERATING INSTRUCTIONS

(1) Switch ON AC supply.
(2) Switch on 24 Volt DC supply for transmission.
(3) Wait 15 minutes (warming up period).
(4) Switch on ROD POWER.
Check ROD CURRENT.
(5) Place meter switch to SPEED.
(6) Check balance of speed amplifier. Make SG adjust RV3 as necessary. Release SG.
(7) Switch on SPEED ARMATURE.
(8) Operate switch SH and check directional sense of speed servo.
(9) Place meter switch to DISTANCE and check balance of distance amplifier. Make switch SD. Adjust RV1 as necessary, release SD.
(10) Switch on DISTANCE ARMATURE
(11) Operate switch SE and check directional sense of DISTANCE servo.
(12) Operate DUMMY signal switch SK to PLUS 1 KNOT. The SPEED indicator dial should read 1 KNOT ± 0.1 KNOT.
(13) Operate DUMMY signal switch to +10 KNOTS. SPEED indicator dial should read 10 KNOTS ± 0.1 knot.
(14) If satisfactory, place DUMMY signal switch to RUN, switch OFF Speed and Distance Armatures and Rod Power Supply.

ROUTINE FOR PUTTING LOG INTO OPERATION:

The following supplies are switched ON.

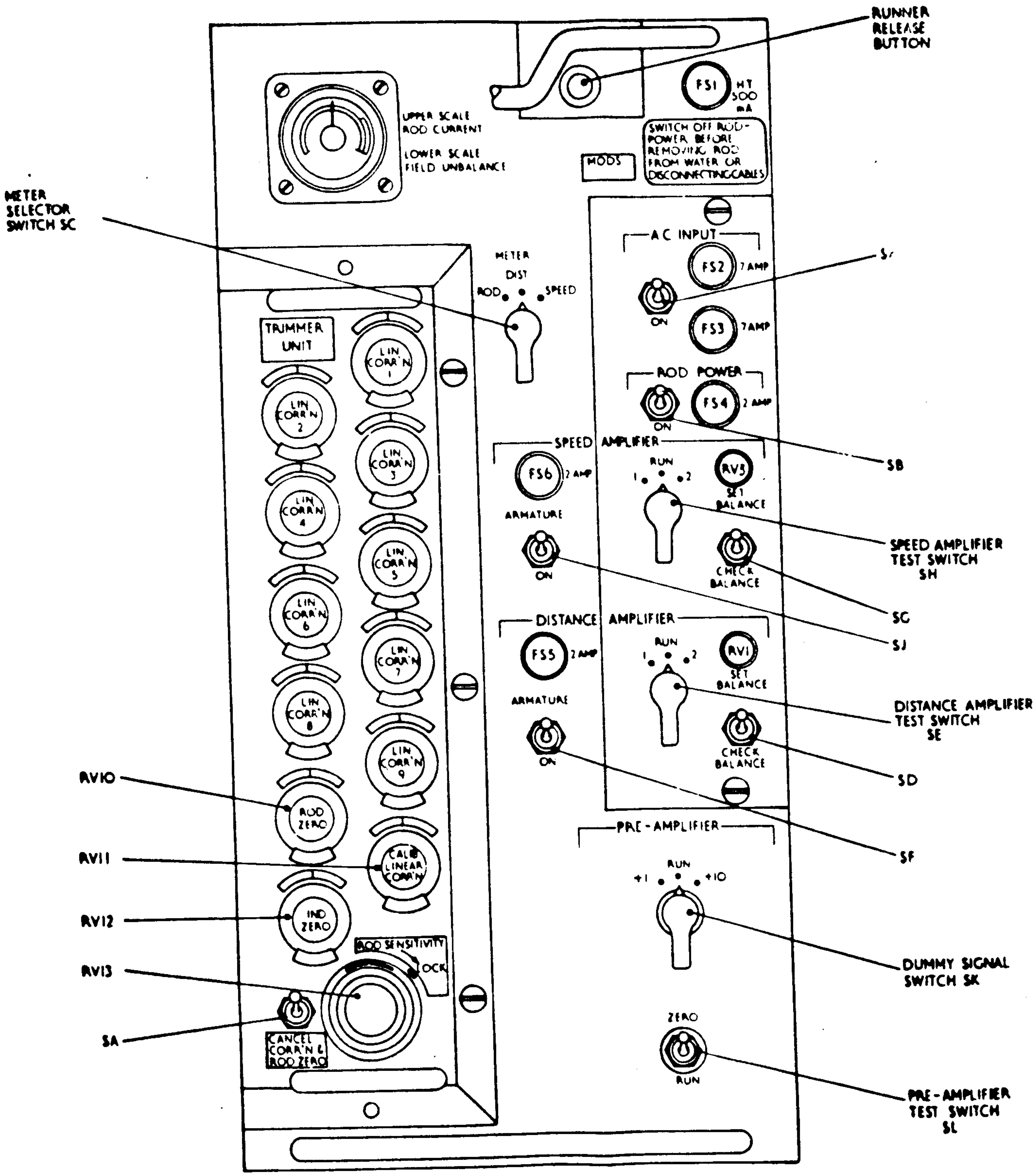
(1) AC (Left on from previous checks)
(2) 24 Volt DC
(3) Rodmeter Power
(4) Speed Armature
(5) Distance Armature

The indicator lamp (230 VOLT NEON) in the Speed and Distance Transmitter Unit will only light when circuits 1,3,4 and 5 have been energised.

NOTES:

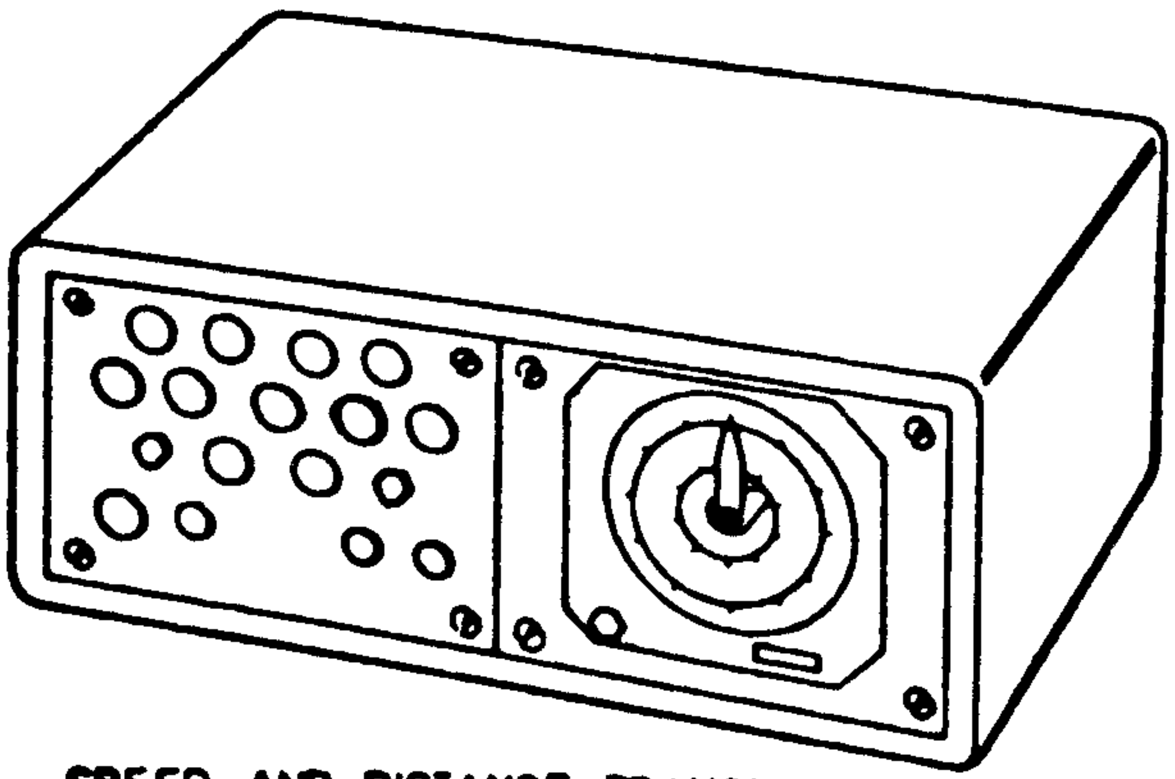
Do not switchon Rodmeter coil supply when the Rodmeter is out of the water or when cables are disconnected. If power is supplied to Rodmeter coil when Rod is not in water, overheating of the Rod coil will occur.

If power is required to operate the system without the Rodmeter, a dummy load resistor must be inserted in lieu of the Rod Coil.
CODOCK HAVE THIS DUMMY LOAD

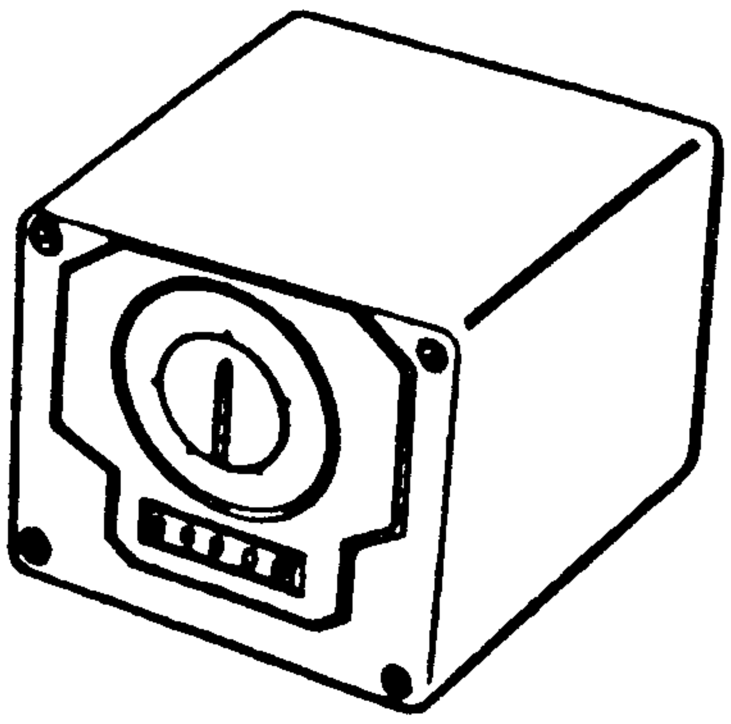


CONTROLS ON FRONT PANEL OF POWER SUPPLY AND AMPLIFIER UNIT

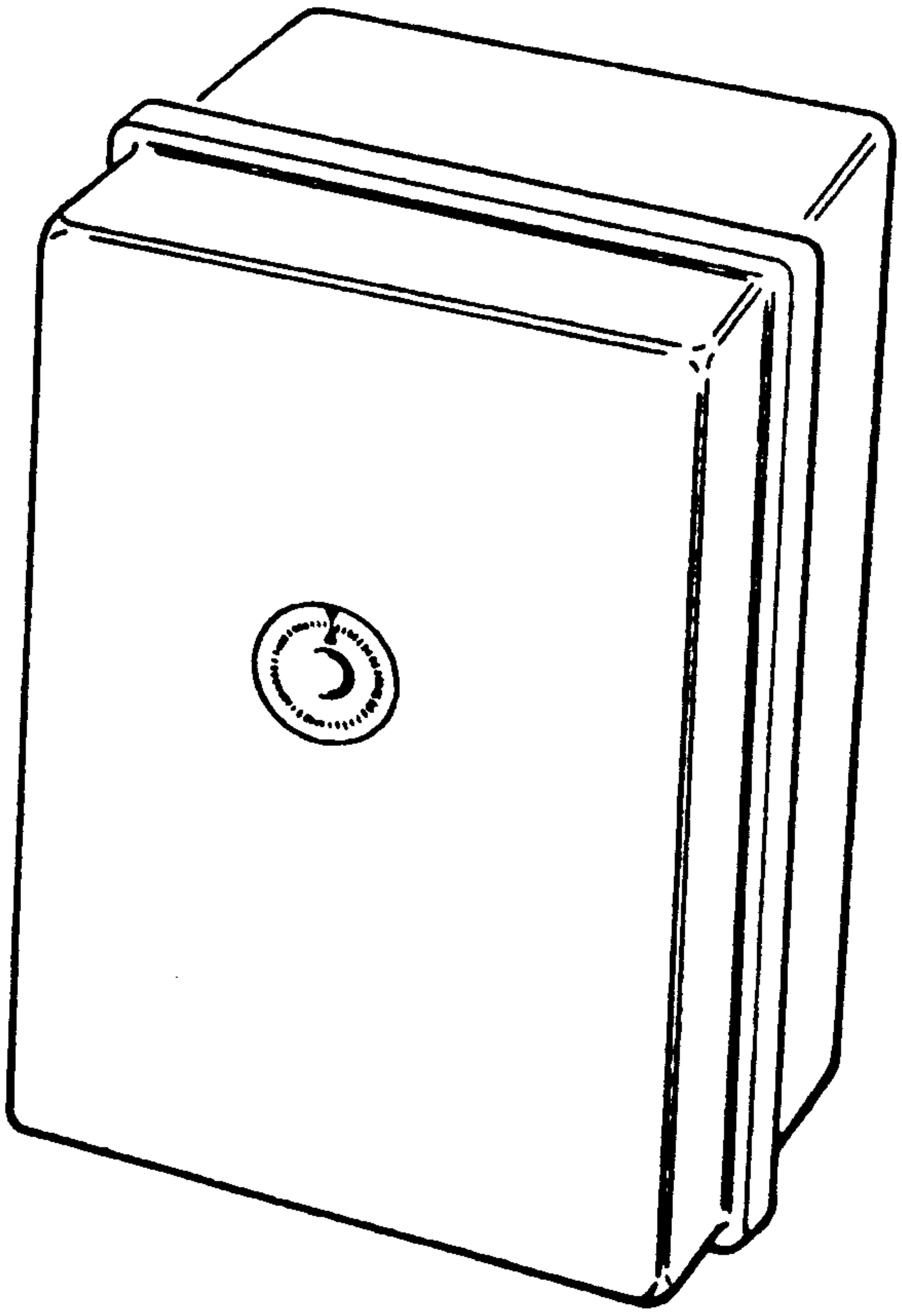
TRANSISTORISED ELECTRO-MAGNETIC LOG



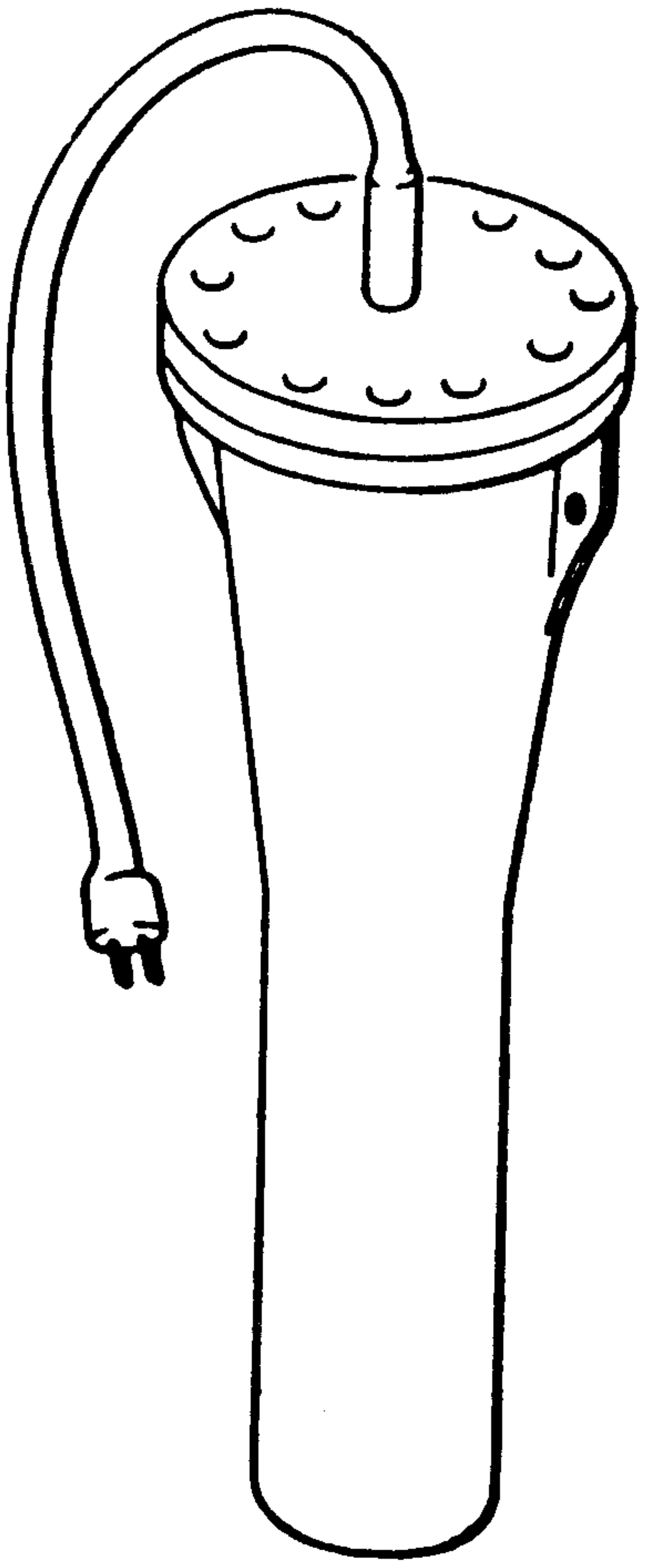
SPEED AND DISTANCE TRANSMITTER



VCS TYPE 84 UNIT



RETRANSMISSION UNIT



FIXED PROBE

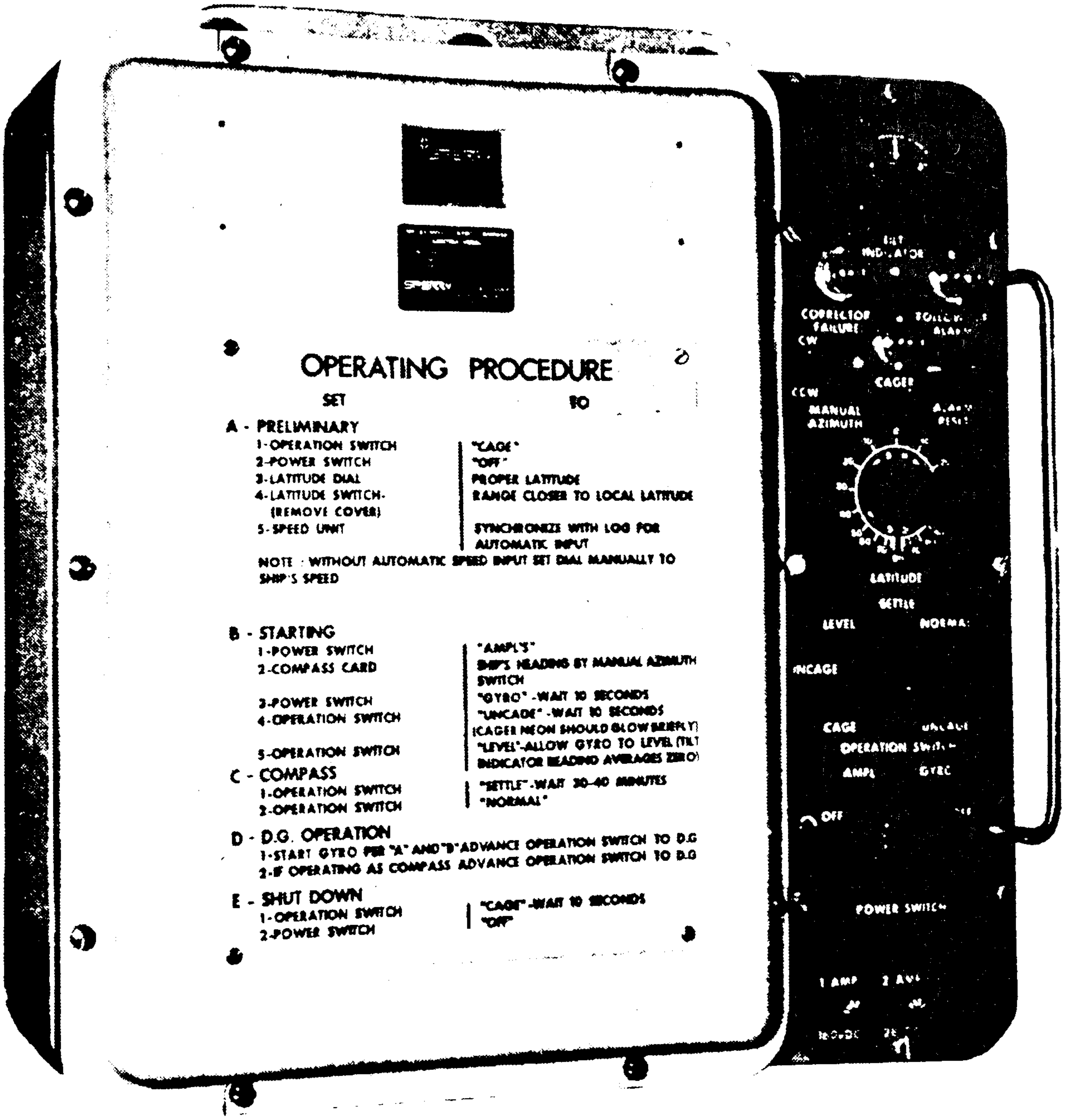
TRANSISTORISED E.M. LOG.

QUICK REFERENCE DATA.

POWER REQUIREMENTS..................................115v 60Hz.
24v DC.

LOG ACCURACY.. ± 0.1 KNOTS.

HANDBOOK..........................BR. 6503 OPERATION AND MAINTENANCE.



OPERATING PROCEDURE

SET	TO
A - PRELIMINARY	
1-OPERATION SWITCH	"CAGE"
2-POWER SWITCH	"OFF"
3-LATITUDE DIAL	PROPER LATITUDE
4-LATITUDE SWITCH- (REMOVE COVER)	RANGE CLOSER TO LOCAL LATITUDE
5-SPEED UNIT	SYNCHRONIZE WITH LOG FOR AUTOMATIC INPUT

NOTE : WITHOUT AUTOMATIC SPEED INPUT SET DIAL MANUALLY TO SHIP'S SPEED

SET	TO
B - STARTING	
1-POWER SWITCH	"AMPL'S"
2-COMPASS CARD	SHIP'S HEADING BY MANUAL AZIMUTH SWITCH
3-POWER SWITCH	"GYRO" -WAIT 10 SECONDS
4-OPERATION SWITCH	"UNCAGE" -WAIT 10 SECONDS (CAGER NEON SHOULD GLOW BRIEFLY)
5-OPERATION SWITCH	"LEVEL"-ALLOW GYRO TO LEVEL (TILT INDICATOR READING AVERAGES ZERO)
C - COMPASS	
1-OPERATION SWITCH	"SETTLE"-WAIT 30-40 MINUTES
2-OPERATION SWITCH	"NORMAL"

D - D.G. OPERATION

1-START GYRO PER "A" AND "B" ADVANCE OPERATION SWITCH TO D.G

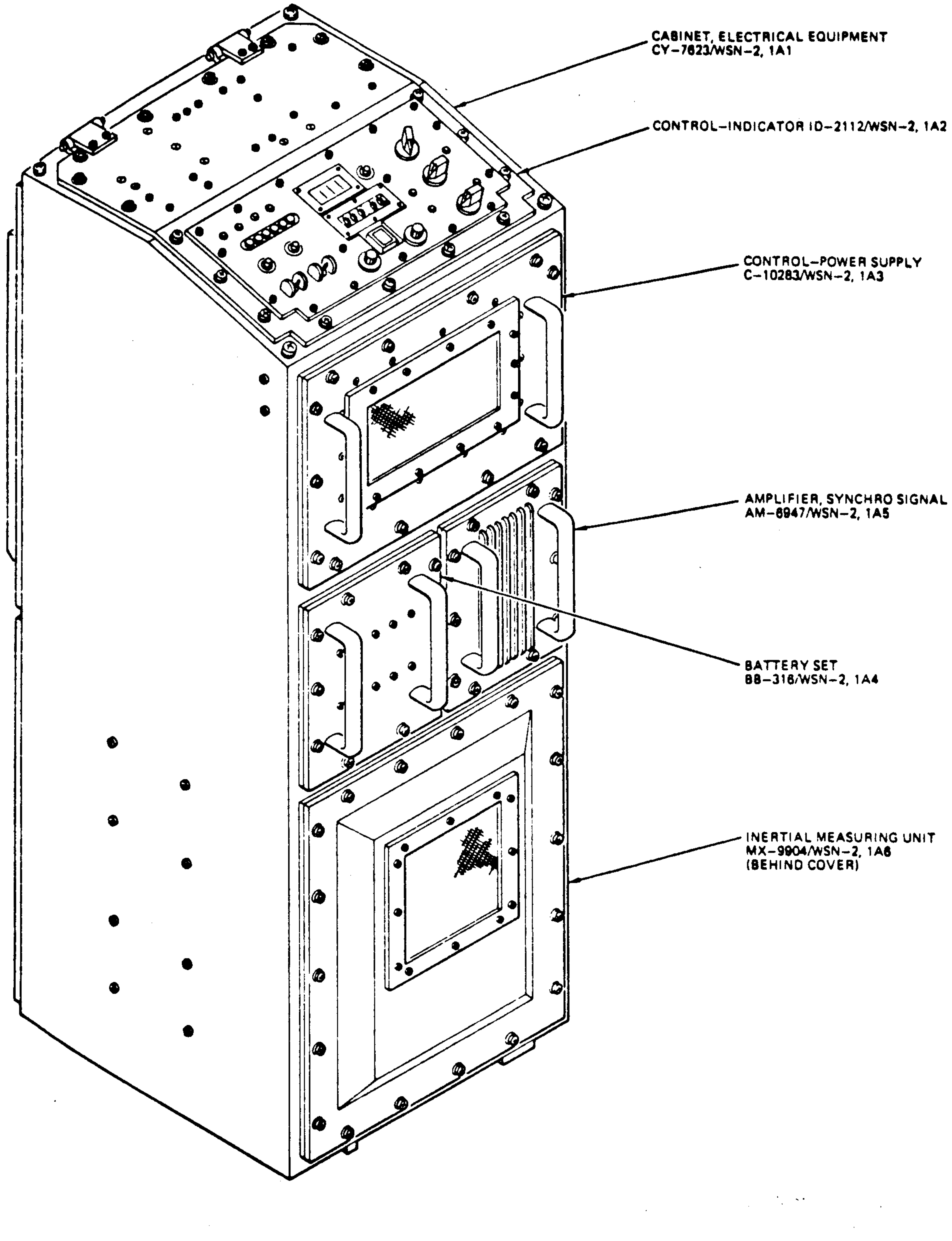
2-IF OPERATING AS COMPASS ADVANCE OPERATION SWITCH TO D.G

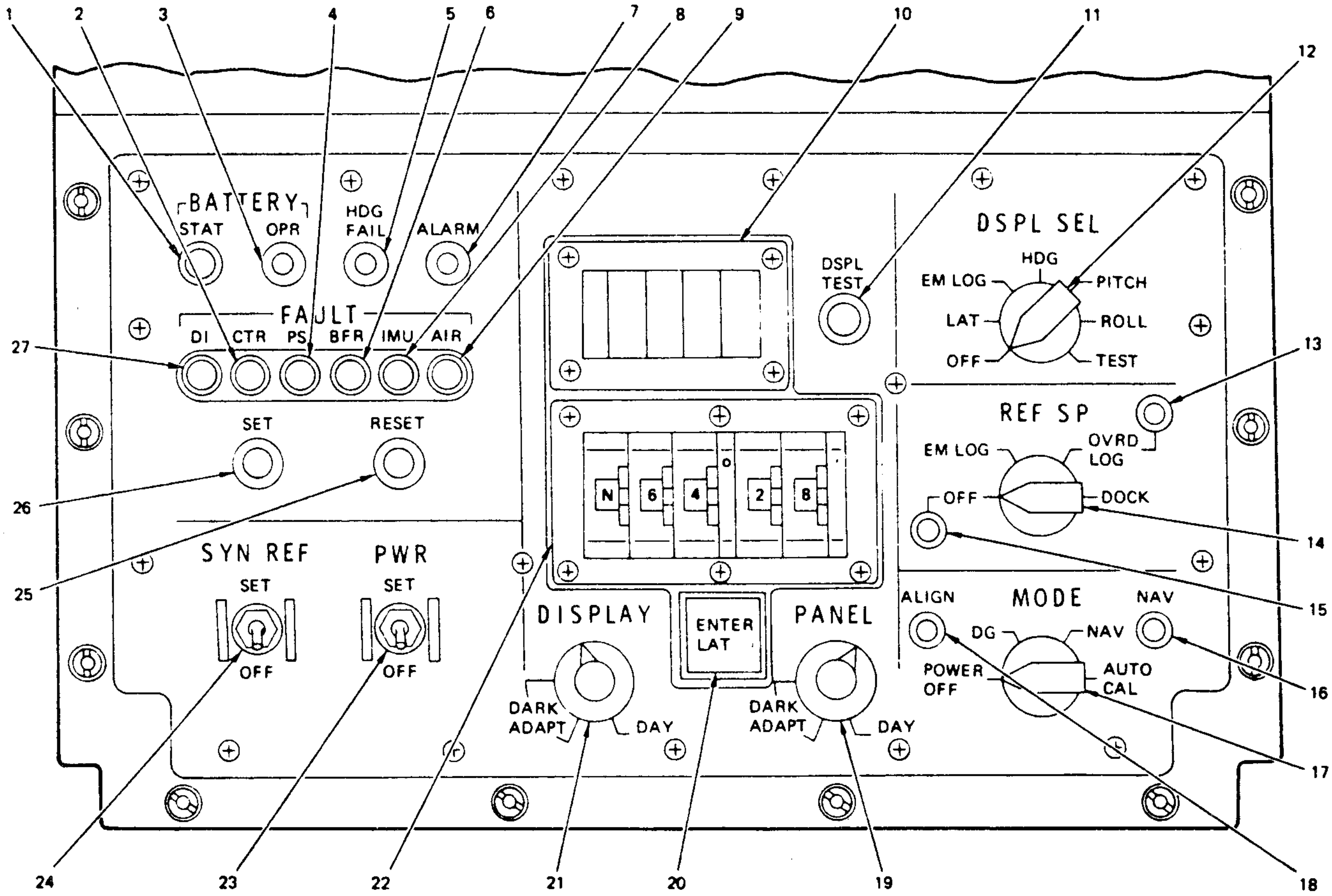
SET	TO
E - SHUT DOWN	
1-OPERATION SWITCH	"CAGE" -WAIT 10 SECONDS
2-POWER SWITCH	"OFF"

Fig. 3.1A Control Cabinet (Post-Mod 8)

AN/WSN-2

1 Ensure MODE switch is to off.
2 Set REF SP switch to EM LOG or DOCK.
3 Set SYN REF circuit breaker to SET.
4 Set PWR circuit breaker to SET.
5 Set MODE switch to NAV (navigate)
6 Adjust PANEL and DISPLAY elumination to sute.
7 At this stage the MODE ALIGN indicator is on and the HDG FAIL indicator is on. These indicators will remain on for the gyro run up period (20 min) if these indicators burn longer than 20 min. then report this to the CPOETS or POETS.
8 After the end of the 20 min. period the MODE NAV indicator burns and the HDG FAIL indicator is off, MODE ALIGN is on.
9 Press the BITE reset push button cheak fault indicators have reset and no fault mode is displayed.
10 Esure the battery STAT and OPR indicators are off.
11 Power off routine.
12 Set MODE switch to POWER OFF .
13 Set SYN REF and PWR circuit breakers to off.


CABINET, ELECTRICAL EQUIPMENT
CY-7623/WSN-2, 1A1
CONTROL-INDICATOR ID-2112/WSN-2, 1A2
CONTROL-POWER SUPPLY
C-10283/WSN-2, 1A3
AMPLIFIER, SYNCHRO SIGNAL
AM-6947/WSN-2, 1A5
BATTERY SET
BB-316/WSN-2, 1A4
INERTIAL MEASURING UNIT
MX-9904/WSN-2, 1A6
(BEHIND COVER)



1. BATTERY, STAT indicator
2. FAULT, CTR indicator
3. BATTERY, OPR indicator
4. FAULT, PS indicator
5. HDG FAIL indicator
6. FAULT, BFR indicator
7. ALARM indicator
8. FAULT, IMU indicator
9. FAULT, AIR indicator
10. Display
11. DSPL TEST pushbutton switch
12. DSPL SEL switch
13. REF SP, OVRD LOG indicator
14. REF SP switch
15. REF SP, OFF indicator
16. MODE, NAV indicator
17. MODE switch
18. MODE, ALIGN indicator
19. PANEL potentiometer
20. ENTER LAT swtich-indicator
21. DISPLAY potentiometer
22. Latitude thumbwheel switch
23. PWR circuit breaker
24. SYN REF circuit breaker
25. FAULT, RESET pushbutton switch
26. FAULT, SET pushbutton switch
27. FAULT, DI indicator

Controls and Indicators

1006 HARBOUR CHECKS

START UP ROUTINE

1. See the officer of the day and obtain permission to raise and operate radar for harbour checks.

2. Throw two buckets of water over the crane seal at the base of the aerial.

3. Ensure the main power unit is on. This unit is located in the radar office under the 1006 Tx/Rx unit. The indicating lights should be burning in the configuration shown below.

ARH		OFF
AERIAL SUPPLY	- INPUT	ON
	- OUTPUT	OFF
INVERT SUPPLY	- INPUT	ON
	- OUTPUT	ON

The 1006 radar is supplied by 115 volts 3 phase 60 hertz

4. Raise the mast (observing all the normal safety precautions).

5. Make the interlock switch at the after end of the chart table.

6. Switch aerial rotation unit on. This is located under the JUD display in the control room.

7. Switch on the 1006 radar by switching to Tx/Rx on the transmitter receiver unit. The indicating lights burn as follows.

ARH	OFF
180 Volts	ON
Tx	ON*

* After approx. 3 minutes and provided the mast is raised.

8. Perform front panel checks as per BR 4200.

9. Check master display switch is to "A" display. This switch is located in the radar office in far right hand corner of the office looking foreward. ("A" display is in the control room, "B" display is in the radar office.)

10. Turn on and check display as follows.
    a) Turn ON/OFF BRILLIANCE switch fully clock wise.
    b) Turn VIDEO GAIN, SWEPT GAIN and DIFF GAIN all fully anti clock wise.
    c) CENTRE switch to CENTRE.
    d) PULSE LENGTH switch to "N" (Normal).
    e) Turn VIDEO GAIN clock wise until a picture is obtained.
    f) Check picture quality on all range scales, ensure SWEPT and DIFF GAIN are working.

g) Switch on SHIPS HEAD MARKER and check it is with in one degree of the gyro repeats.

h) Operate BEARING MARKER check that the TRUE/RELATIVE numeric display changes with the operation of the TRUE/RELATIVE toggle switch.

i) Check the operation of the RANGE (CAL) RINGS by comparing them with the RANGE STROBE MARKER and the BEARING CURSOR lines on all range scales.

NOTE:On the 0.75 mile, 0.5 mile and 64 mile ranges the CAL RINGS will not line up with the BEARING CURSOR lines.

SHUT DOWN ROUTINE

1. Turn off the display as follows.
   a) Turn VIDEO, SWEPT and DIFF GAIN fully anti clock wise.
   b) Turn the ON/OFF BRILLIANCE switch fully anti clock wise.

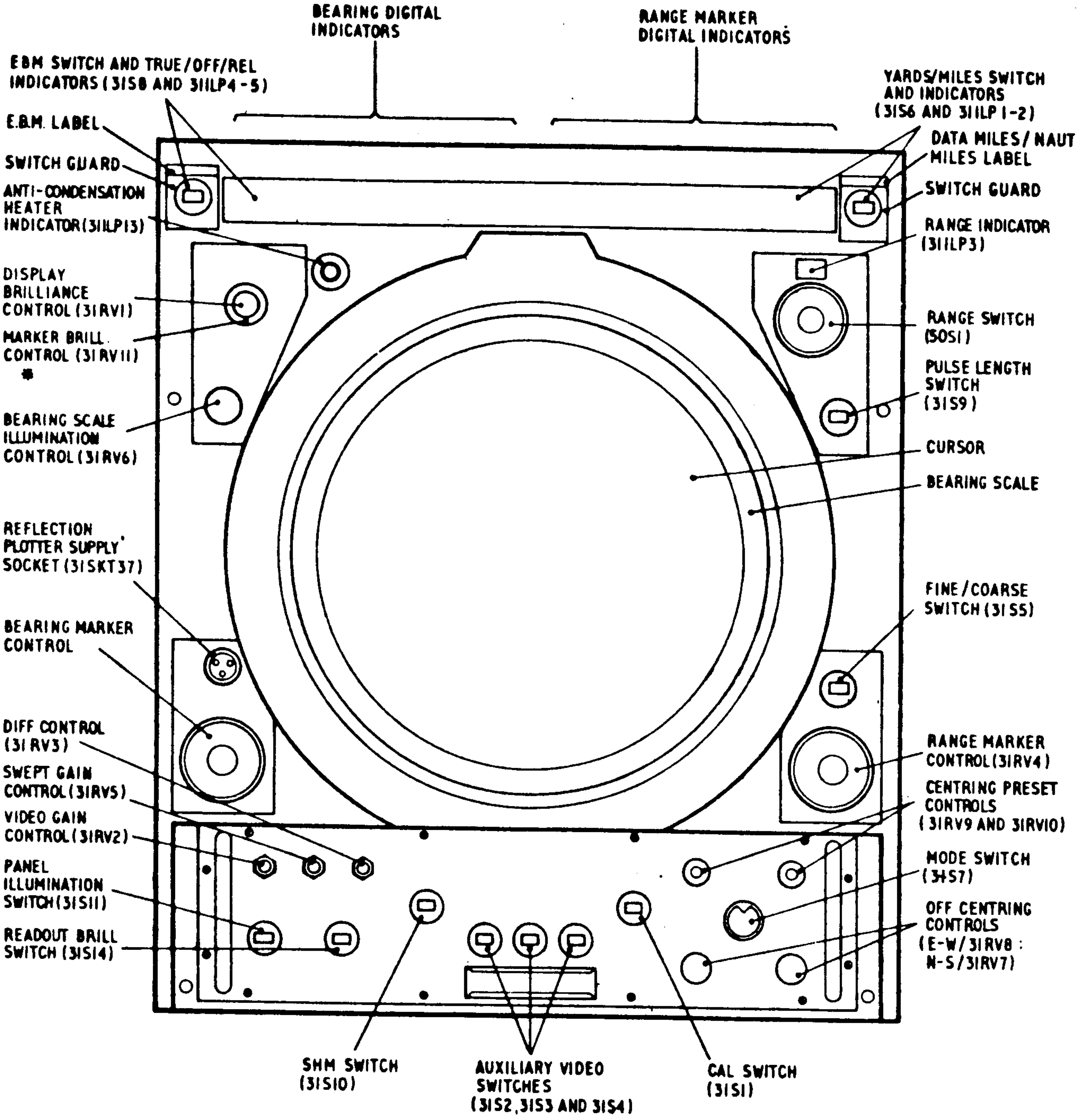
2. Switch off aerial rotation unit.

3. Switch off interlock.

4. Lower radar mast (observing all the normal safety precaultions).

5. Report to the officer of the day (OOD) and the CPOETS that "radar harbour checks complete." if there are any defects found report them to the CPOETS.

6. If doing a complete shut down switch RADAR STATE switch to off.


BEARING DIGITAL INDICATORS
RANGE MARKER DIGITAL INDICATORS
EBM SWITCH AND TRUE/OFF/REL INDICATORS (31S8 AND 311LP4-5)
E.B.M. LABEL
SWITCH GUARD
ANTI-CONDENSATION HEATER INDICATOR (311LP13)
DISPLAY BRILLIANCE CONTROL (31RV1)
MARKER BRILL. CONTROL (31RV11) *
BEARING SCALE ILLUMINATION CONTROL (31RV6)
REFLECTION PLOTTER SUPPLY SOCKET (31SKT37)
BEARING MARKER CONTROL
DIFF CONTROL (31RV3)
SWEPT GAIN CONTROL (31RV5)
VIDEO GAIN CONTROL (31RV2)
PANEL ILLUMINATION SWITCH (31S11)
READOUT BRILL SWITCH (31S14)
YARDS/MILES SWITCH AND INDICATORS (31S6 AND 311LP1-2)
DATA MILES/NAUT MILES LABEL
SWITCH GUARD
RANGE INDICATOR (311LP3)
RANGE SWITCH (50S1)
PULSE LENGTH SWITCH (31S9)
CURSOR
BEARING SCALE
FINE/COARSE SWITCH (31S5)
RANGE MARKER CONTROL (31RV4)
CENTRING PRESET CONTROLS (31RV9 AND 31RV10)
MODE SWITCH (31S7)
OFF CENTRING CONTROLS (E-W/31RV8 : N-S/31RV7)
SHM SWITCH (31S10)
AUXILIARY VIDEO SWITCHES (31S2, 31S3 AND 31S4)
CAL SWITCH (31S1)

* MARKER BRILLIANCE CONTROL
DISPLAY OUTFIT NSN 5840-99-531-1103 ONLY

Display Unit Controls

OBERON CLASS INTERNAL COMMUNICATIONS

1. Relevant and associated systems are described in the following handbooks:

a. BR 1964 (19C) Internal Communications Oberon Class Submarines.

b. ABR 5146 Service Handbook for Transistorised Audio Frequency Terminal Eqpt.

c. BR 4567 (601) Microphones.

d. BR 4567(602) Loudspeakers.

e. BR 4567(606) Noise Excluding Headsets.

f. BR 4567(608) Headsets.

g. BR 4567(609) Handsets.

2. TYPES OF BROADCAST AND COMMUNICATION

Main Broadcast
Action Intercom (Radar/Sonar)
Engine Room/Motor Room Loop
Interphone Systems
Sound Powered Phones

3. GENERAL

Main and action broadcast share a common intercom and broadcast control box situated in the control room, mounted port side above the Officer of the Watch Panel.
There are four broadcast amplifiers (A, B, C and D), all of which are rated at 20 watts output. A, B and C amplifiers are mounted on racks in the gyro shack. D amplifier is mounted on the fwd. radar office bulkhead in the AMS.
Switching of input signals to, and output signals from these amplifiers is controlled by four switches (A, B, C and D) on the control box.

4. WITH ALL SWITCHES ON

Amplifiers A and B share the MAIN intercom
Amplifier C supplies the RADAR intercom
Amplifier D supplies the SONAR intercom

5. IN AN EMERGENCY

Switching 'OUT' AMP A will cause the main intercom to be supplied from AMP B.
Switching 'OUT' AMP B will cause the main intercom to be supplied from AMP A.
Switching 'OUT' AMP C will cause AMP A to take over the main intercom and AMP B will supply the RADAR intercom.
Switching 'OFF' AMP D (mid-position) will render the SONAR intercom inoperative.
Switching 'OUT' AMP D (down position) will cause AMP C to take over the SONAR intercom as well as continuing to supply the RADAR intercom.

6. MAIN CONTROLS

Individual Switches

Twelve selected switch positions to which the main intercom may be broadcast.

Main Broadcast and Alarm Switch

By-passes the individual switches and allows main broadcast to be made over the whole system.

Alarm Switch

Transmits the output of a 24V DC oscillator to the main intercom microphone input feeds.

Bridge Isolating Switch

Isolates all bridge circuits to prevent any flooding of units affecting the whole system.

Press to call Switches

Provides lamp and/or buzzer call up to five(5) outstations.

7. BRIDGE COMMUNICATIONS

The OOW headset and bridge loudspeaker/microphone unit are permanently connected to the output of the system. Speech into any microphone on the system is therefore monitored at the OOW and Bridge positions.

8. ENGINE ROOM/MOTOR ROOM LOOP

Two twenty(20) watt amplifiers with parallel inputs.
The output of one amplifier supplies speakers in the Engine Room and Motor Room.
The other amplifier supplies an inductive loop around the Engine Room and Motor Room.
Engine Room personnel wear Noise Excluding Headset receivers to receive orders broadcast over the inductive loop.

NOTE: Main broadcast is also induced into the loop.

9. CONTROL ROOM LOOP

In the Control Room, there is an inductive loop similar to that in the Engine Room which is used by the Officer of the Watch on the after periscope. The Officer of the Watch wears a small receiver/battery pack on his belt, and his headset plugs into this pack. The Control Room loop can be isolated by a switch at the fwd. end of the chart table.

10. INTERPHONE SYSTEM

Two separate 24V DC systems allowing communications to be established between selected outstations by HANDSET and/or HEADSET.

No.1 SYSTEM (Control Switchbox in the CONTROL ROOM)

Communications to and between:

1. Fore-ends.
2. Junior Sailors Mess.
3. Senior Sailors Mess.
4. Gash Ejector Space.
5. Wardroom.
6. AMS.
7. Engine Room.
8. Motor Room.
9. After ends.
10. Interconnect System 2.

No. 2 SYSTEM (Control Switchbox in the SOUND ROOM)

Communication to and between:

1. TOAD.
2. WDC.
3. Wireless Office.
4. FCC.
5. Chart Table.
6. Radar Office.
7. Gyro Office.
8. Interconnect System 1.

Establishing communication between 1 or more outstations is made via No.1 or No.2 Control Box which provides lamp and buzzer call up to all outstations.

11. SOUND POWERED TELEPHONES

1. Fitted either side of 34 bulkhead watertight door.
2. Accomodation Space.
3. OOW Position.
4. Engine Room.
5. Either side of 103 bulkhead watertight door.

They have no call up facility, are all interconnected and are only manned in an emergency.

12. SONAR INTERCOM

Uses a twenty(20) watt amplifier in conjunction with the Sonar Control Officers' Control Box. The Control Box has two switches:

1. SONAR/ACTION switch.
2. SONAR Selector Switches.

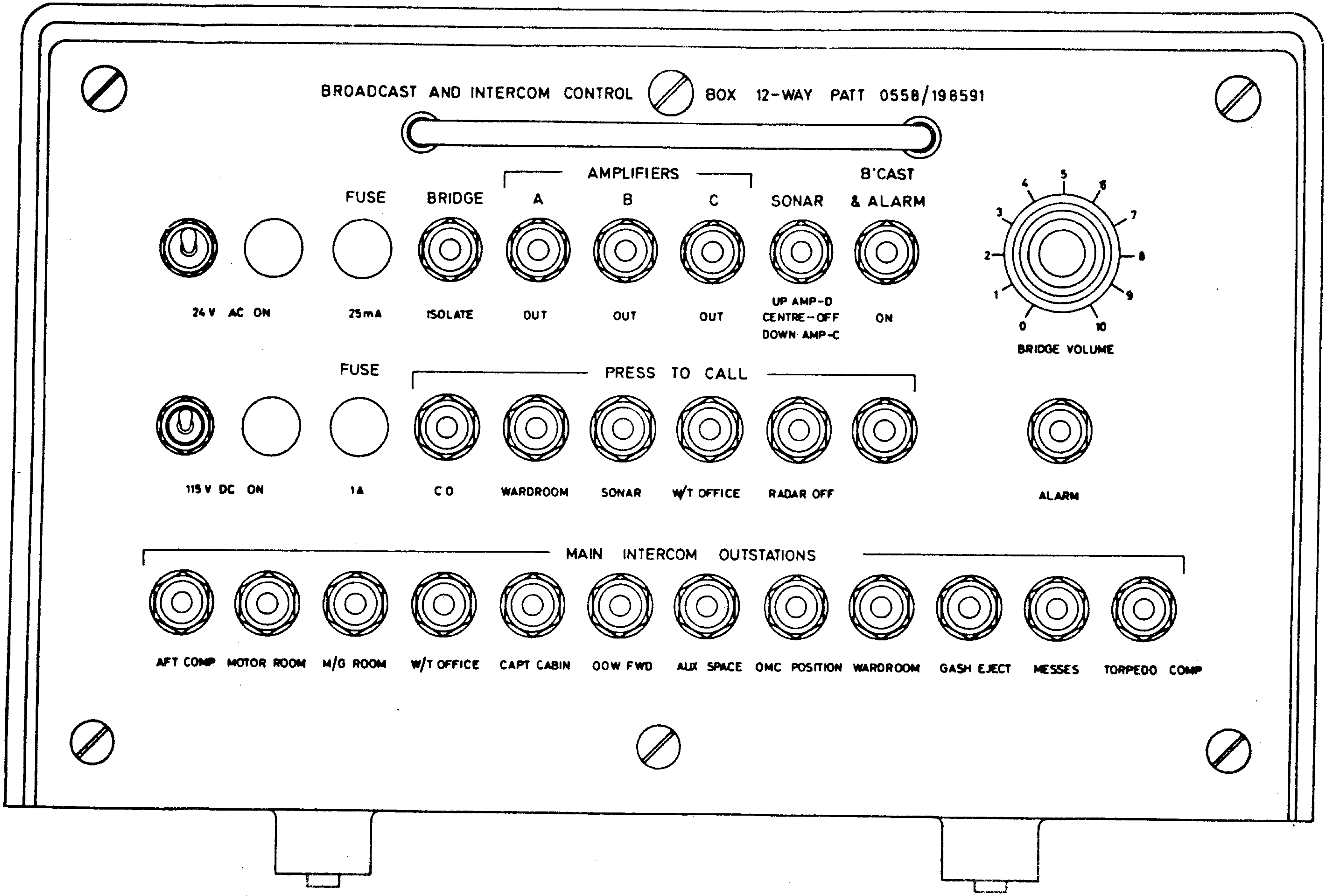
In the ACTION position, the system is normally an intercom between the Control Room and Sound Room.

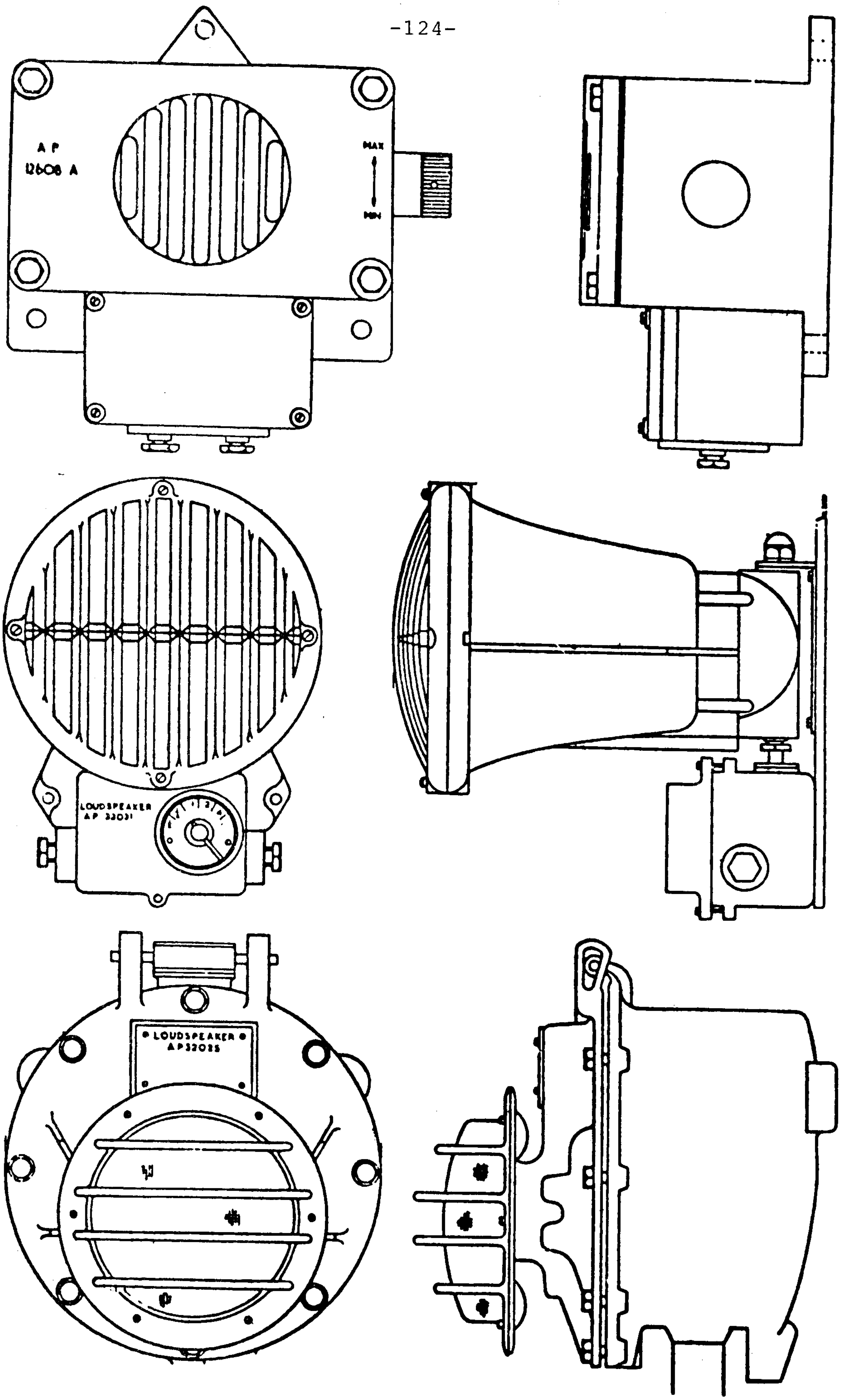
In the SONAR position, the Control Officer wears a split headset, which used in conjunction with the Selector Swutch, enables him to monitor any selected sonar set through one earpiece and to hear microphone reports through the other. As well as monitoring, SCO can talk directly to the selected operator using his microphone to induce speech into the monitored headset line.

SONAR SUPERVISORS' SWITCH BOX

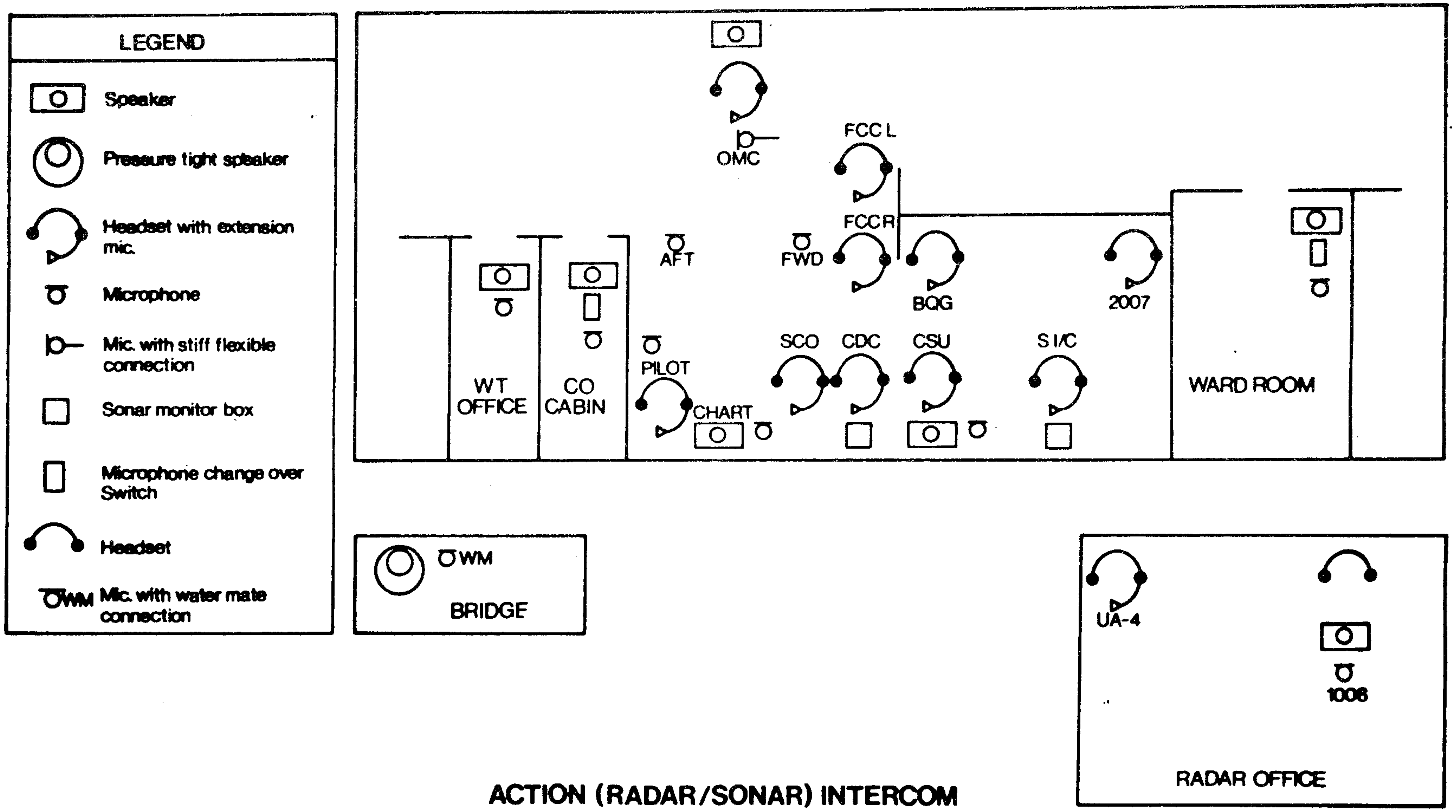
Fitted in the Sound Room. Enables the supervisor to monitor any selected set and to hear intercom traffic. Again makes use of a split headset. The supervisor has a microphone but no ACTION INTERCOM facilities.

Microphones are fitted at all positions and a Sonar Assignment Panel is incorporated to allow the monitored output of all Sonar sets to be selected onto a tape recorder.

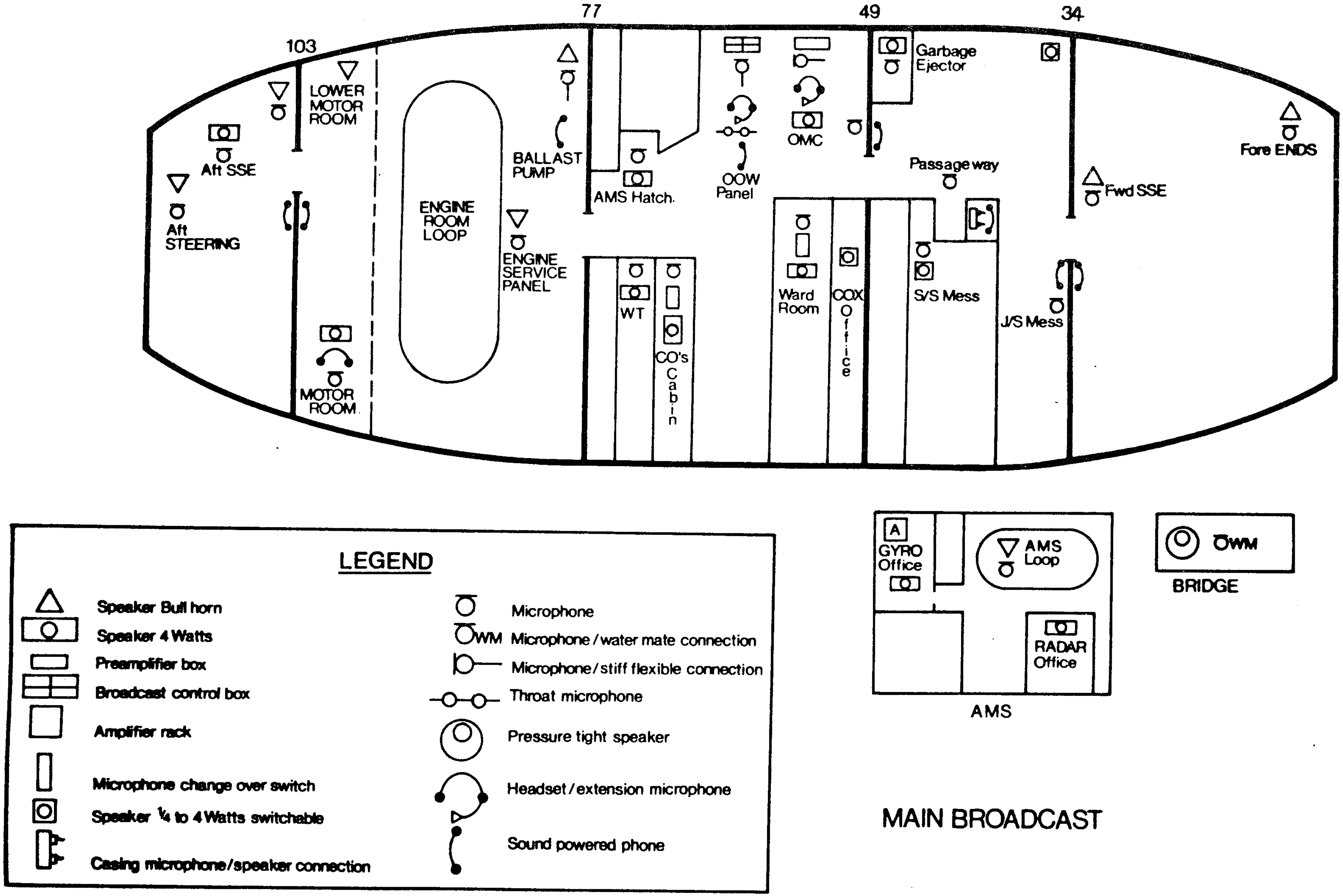

BROADCAST AND INTERCOM CONTROL BOX 12-WAY PATT 0558/198591
AMPLIFIERS
B'CAST & ALARM
FUSE
BRIDGE
A
B
C
SONAR
24 V AC ON
25mA
ISOLATE
OUT
OUT
OUT
UP AMP-D CENTRE-OFF DOWN AMP-C
ON
0
1
2
3
4
5
6
7
8
9
10
BRIDGE VOLUME
FUSE
PRESS TO CALL
115 V DC ON
1A
C O
WARDROOM
SONAR
W/T OFFICE
RADAR OFF
ALARM
MAIN INTERCOM OUTSTATIONS
AFT COMP
MOTOR ROOM
M/G ROOM
W/T OFFICE
CAPT CABIN
OOW FWD
AUX SPACE
OMC POSITION
WARDROOM
GASH EJECT
MESSES
TORPEDO COMP



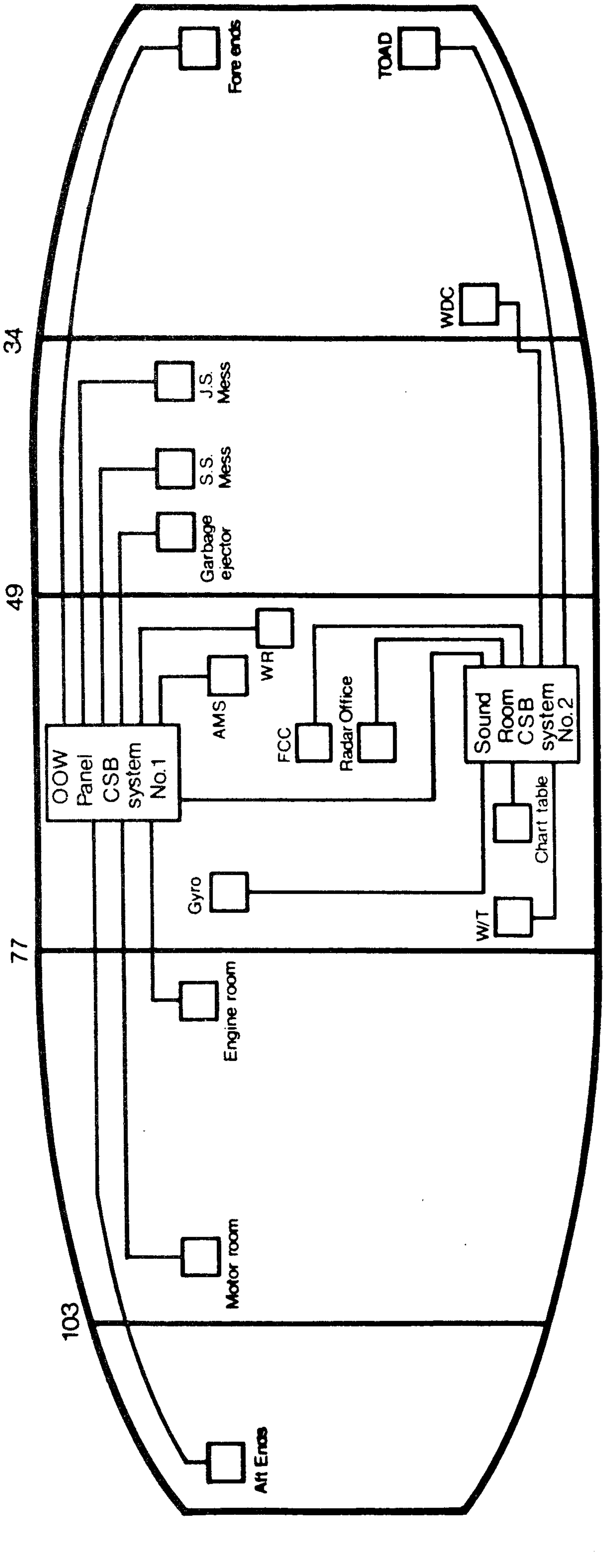
LOUDSPEAKERS



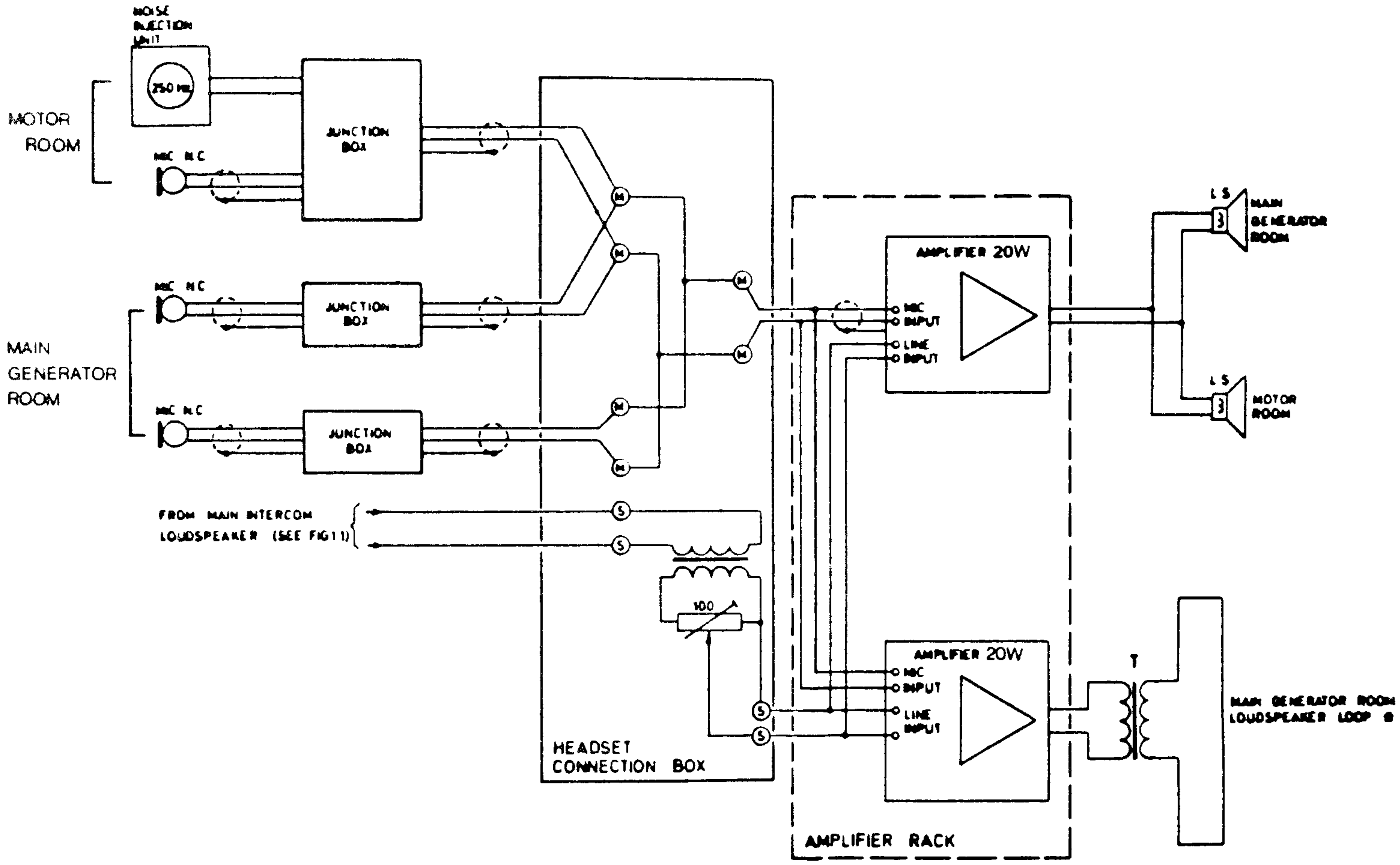
ACTION (RADAR/SONAR) INTERCOM



MAIN BROADCAST



INTERPHONE SYSTEMS ONE & TWO



* NOTE: LOOP CONNECTED VIA A J.B TO TERMINALS OF TRANSFORMER

GENERATOR AND MOTOR ROOM SYSTEM – BLOCK DIAGRAM

Duty LSETP

The Duty LSETP duty statement is as follows :

a. Accountability

The Duty LSETP (DET) is accountable to the Duty Petty officer (DPO).

b. Tasks

(1) To operate and ensure the safety of all electrical equipment in the submarine out of working hours.

(2) To carry out charges in accordance with RANSSO and WEEO Standing orders.

(3) To carry out checks in accordance with RANSSO chapter 2 before a trot move.

(4) To operate the main propulsion switchboard during trot movements.

(5) To take pilot cell readings at 0800 and 2000 and record them on the battery state board outside the Wardroom, and in the battery log.

(6) To run battery ventilation for half an hour at 0800 and before evening rounds.

(7) To run battery cooling in accordance with RANSSO.

(8) To rig casing, anchor, and side illumination lights as applicable, test them one hour before sunset and report them to the Duty Petty Officer, then switch them on at sunset.

(9) To ensure the cleanliness of the motor room.

(10) To stand rounds in the motor room and report the following to the OOD :

- (i) pilot cell readings
- (ii) battery sump state. If not dry, the cause is to be traced and rectified, and the sump dried out
- (iii) motor room bilge state, bilge alarm functionally checked
- (iv) battery ventilated
- (v) rounds of running electrical machinery carried out, and the motor room log completed
- (vi) any defects, including earths, and progress made in eliminating them
- (vii) switch off all unnecessary lighting at secure and pipe down

LIST OF ELECTRICAL B.R.'s

B.R.	158	Examples in electrical calculations
B.R.	1159	Electronic test methods
B.R.	1923(2)	Substitution guide for electronic components
B.R.	1964(10)	Ships and battery ventilation
B.R.	1964(19A)	Electrical propulsion equipment
B.R.	1964(19B)	Electrical conversion equipment
B.R.	1964(22)	Type NC2 circuit breakers
B.R.	2199	Hydrogen contents meter
B.R.	2508	Synchros and accesories
B.R.	6524	Automatic emergency lantern
B.R.	2075X	Submarine main battery
B.R.	4500(701)	Batteries primary and secondary
B.R.	268(47A)	Electric salinity meters
B.R.	2502	Automatic voltage regulators (Mk 51,52,53,58)
B.R.	1964(19C)	Internal communications "O" class submarines
B.R.	4567(606)	Noise excluding headsets
B.R.	4567(608)	Headsets
B.R.	4567(609)	Handsets
A.B.R.	5146	Service handbook for transistorised audio frequency terminal equipment.